Stormwater Management Report

Canadore College

Type of Document:
DRAFT

Project Name:
Canadore College Long Term Care Facility

Project Number:
NTB-23012663-00

Prepared By:
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Date Submitted:
July 8, 2024

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1. Introduction

EXP Services Inc. (EXP) has been retained by Villages Real Estate Holdings (Villages) to prepare this Stormwater Management Report (SWM Report) for the development of the Long-Term Care (LTC) Facility at Canadore College. The LTC is approximately 4,476m^2 with 72 new asphalt parking spaces located at the north and west portion of the existing Canadore College Parking Lot No. 9, north of main campus and south of Cedar Heights Road.

2. Development Location

As indicated above, the proposed building is located where the current west portion of the Canadore College Parking Lot No. 9 is located, north of the main Canadore College campus and south of Cedar Heights Road. Access to the site will be provided from Cedar Heights Road and through the eastern portion of existing Parking Lot No. 9. An existing Canadore College Stormwater Management Pond is located west of the proposed building.

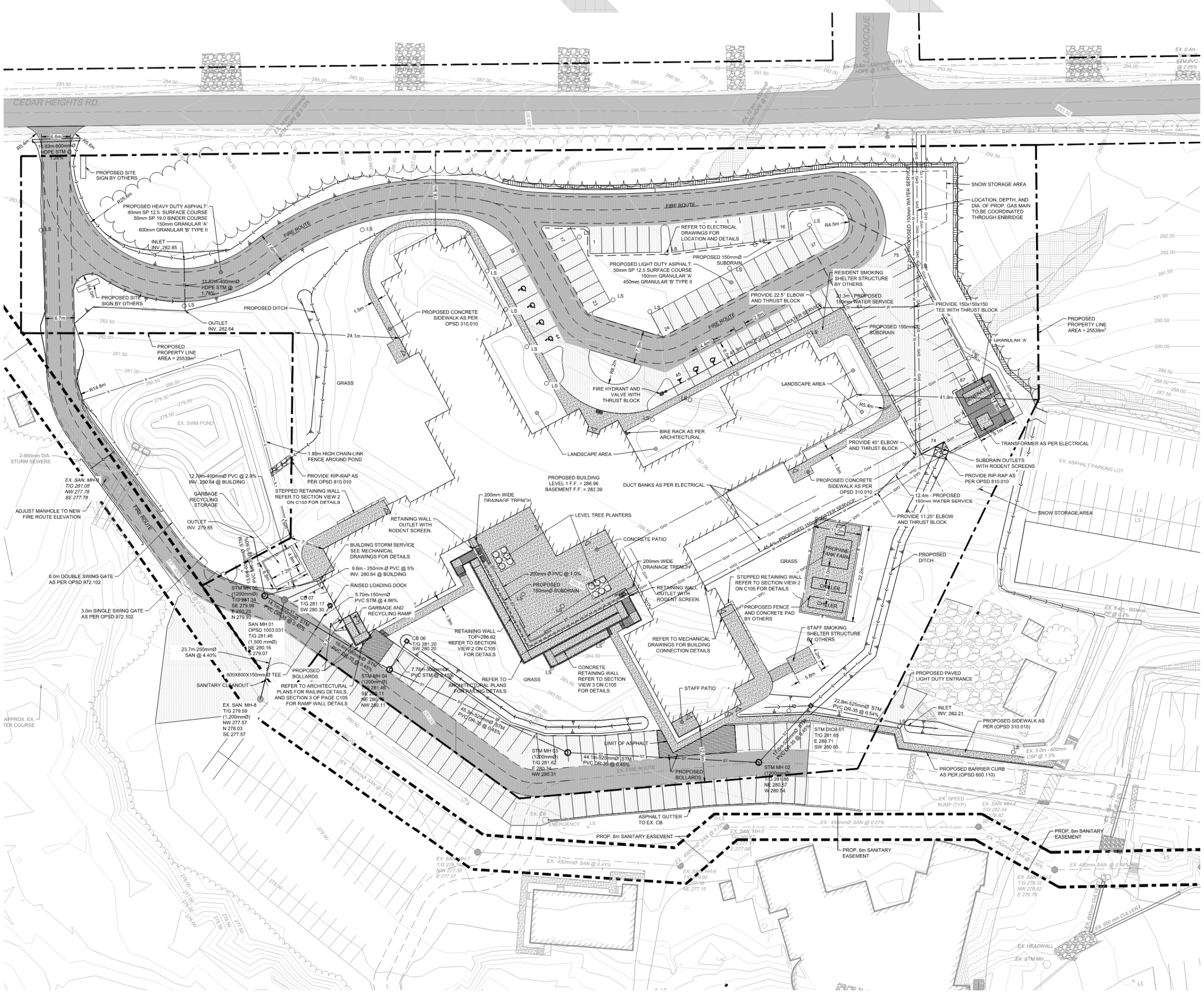


Figure 1: Proposed Site

3. Existing Conditions

The 3.45-hectare (8.40 acres) catchment area is comprised of asphalt parking lots, forest and bedrock outcrops. The existing topography slopes from the north to south with an average slope of approximately 7 percent. Currently, runoff from north of the pond and Parking Lot No. 9 drains east to the Canadore Maintenance Garage and then west to the adjacent Stormwater Management Pond.

The adjacent Stormwater Management Pond controls runoff for Parking Lot No. 9 and discharges flow to the south which is conveyed to the Canadore pond south of the site.

4. Proposed Development

It is proposed to remove the west portion of Parking Lot No. 9 and replace it with the LTC and associated asphalt parking. The site includes a road network and stormwater conveyance to the existing Stormwater Management Pond adjacent to the site and landscape areas as shown in Figure 1. It is proposed that the drainage will remain the same and be conveyed into the existing Canadore Stormwater Management Pond west of the proposed LTC.

5. Existing Stormwater Management Pond

In 2008, Trow Associates Inc. (EXP) prepared a Stormwater Management Report for the construction of the Education Centre New Construction of Parking Lots. The report includes the design of the adjacent Stormwater Management Pond that controls runoff from Parking Lot No. 9 and the area north towards Cedar Heights Road. The 2008 Trow Stormwater Management Report is attached in Appendix E.

The following is a summary of the SWM Pond Characteristics:

- Drainage Area: 4.54 ha
- Imperviousness (%): 62.5
- Extended Detention Treatment Volume Provided: $426m^3$
- Permanent Pool Volume Provided: $839m^3$
- Extended Detention Storage Drawdown: 29 hours
- Quality Control Enhanced 80% TSS Removal
- Forebay Depth: 1.53m
- Forebay Length to Width Ratio: 2:1
- Overall Length to Width Ratio: 3:1
- Permanent Pool Depth: 1.53m
- Extended Detention Depth: 0.30m
- Total Active Storage Depth: 0.40m
- Side Slopes: 5:1 for 3m on permanent pool, 3:1 elsewhere, 3:1 for the forebay berm
- Emergency Overflow Outlet: Sized for the 100-year Storm Event
- Outlet Controls: three (3) orifice pipes

- Orifice Pipes: 200mm diameter orifice pipe set at an elevation of 279.85m

  2- 900mm diameter orifice pipes set an elevation of 280.32m

The following table is a summary of the Storage Volumes and Release Rates at the Outlet of the Pond from the 2008 report.

Table 9.8: Storage Volumes and Release Rates at the Outlet of Pond

Design Storm	Target Flow (m^3/s)	Uncontrolled Post-Development Peak Flow (m^3/s)	Storage Required (m^3)	Storage Used (m^3)	Controlled Post-Development Peak Flow (m^3/s)
SWMM ID->		TR-U 200	TR-I		TR-C 200
2-Year	0.483	0.615	441	705	0.028
5-Year	0.720	0.874	482	864	0.070
25-Year	1.200	1.301	536	1102	0.163
100-Year	1.588	1.805	572	1323	0.304

Note: For the Storage required column, the pond rating curve in TR-I was iterated until the modelled pond outflow (TR-I 107) met the target flow (RO 30)

The development of the LTC is directly adjacent to the existing stormwater management pond and within the catchment area of the pond, we propose to utilize the existing adjacent stormwater management pond for the new Canadore College LTC and associated parking.

6. Pre-Development Drainage Characteristics

In 2008, Trow (EXP) prepared a Stormwater Management Plan for the pond as per **FIG. A1 in Appendix D,** however the proposed northern parking lots and road connecting the parking lots to Cedar Heights Road were not constructed. These parking lots and entrance are not expected to be constructed in the future due to the elevation difference between Parking Lot No. 9 and Cedar Heights Road.

Drainage areas 104 and 106 from the 2008 report were expected to be directed west to the adjacent stormwater management pond, however runoff currently follows the existing drainage ditch east and into the large Canadore Pond south of the site. Due to the effort required to blast rock to allow runoff to drain east it is not expected that these areas will ever drain west to the adjacent stormwater management pond.

We have prepared a current (Pre-Development) Stormwater Management Plan that illustrates the current site drainage conditions. The pre-development flow regime of the site extends northward to Cedar Heights Road and has a total catchment area of 3.45 hectares. The Pre-development Stormwater Management Plan (SWM2) is also provided in **Appendix A**.

Catchment	Wetland/Pond Area (ha)	Granular Area (ha)	Pavement/Roof Area (ha)	Rockland Area (ha)	Woodland Area (ha)	Lawn Area (ha)	Weighted RC	Weighted TIMP (%)
EX1 (Uncontrolled)	0.00	0.02	0.01	0.00	0.14	0.11	0.27	8.3
EX2	0.05	0.05	0.00	0.00	0.24	0.31	0.24	7.9
EX3	0.00	0.06	0.70	0.03	0.28	0.28	0.63	63.4
EX4	0.00	0.00	0.00	0.15	0.68	0.15	0.35	15.1

Site Area = 3.27 ha Imp. Area = 1.20 ha Weighted Runoff Coe. = 0.43 Total Imp. % = 31.4

The runoff coefficient values were taken from the *City of North Bay Engineering Design Guidelines, Table 6.1 Stormwater Runoff Coefficients*. The pre-development composite runoff coefficient for the site is calculated as the weighted average of the different areas of land types.

As shown above, the pond currently operates well below the design criteria of a 4.52 ha drainage area at 62.2% total imperviousness.

7. Post-Development Drainage Characteristics

Post development runoff coefficient estimation have been developed based on the nature of the proposed development containing hard surfaces such as roofs and roads, and soft surfaces such as landscaping and stormwater facilities. A post-development Stormwater Management Plan (SWM3) is provided in **Appendix B**.

Catchment	Wetland/Pond Area (ha)	Granular Area (ha)	Pavement/Roof Area (ha)	Rockland Area (ha)	Woodland Area (ha)	Lawns / Pasture Area (ha)	Weighted RC	Weighted TIMP (%)
C101 (uncontrolled)	0.00	0.03	0.00	0.00	0.00	0.080	0.29	28.8
C102	0.05	0.00	0.26	0.00	0.15	0.42	0.39	29.7
C103	0.00	0.00	0.20	0.00	0.00	0.12	0.63	63.4
C104	0.00	0.05	0.70	0.07	0.29	0.66	0.51	46.7
C105	0.00	0.00	0.08	0.00	0.00	0.00	0.90	100.0
C106	0.00	0.00	0.08	0.00	0.00	0.00	0.90	100.0

Site Area = 3.24 ha Imp. Area = 1.48 ha Weighted Runoff Coe. = 0.50 Total Imp. % = 45.6

The runoff coefficient values were taken from the *City of North Bay Engineering Design Guidelines, Table 6.1 Stormwater Runoff Coefficients*. The post-development composite runoff coefficient for the site is calculated as the weighted average of the different areas of land types.

As indicated above, the anticipated catchment area and total imperviousness of the site will be well below the designed pond criteria as detailed in the 2008 Stormwater Management Report. Therefore, the existing stormwater management pond will provide the quantity and quality controls required to satisfy the reviewing authorities requirements.

8. Storm Pipe Sizing

The site is designed to integrate minor and major storm systems in order to convey minor and major storm runoff via roadside ditches or storm sewers.

Storm sewer pipe size calculations are provided in the storm sewer design sheet in **Appendix C.** The minimum required pipe diameters are sized for conveyance of the peak flow rates of the 10-year design storm under post-development conditions, with a minimum time of concentration of 10 minutes.

9. Quality Control

The existing Stormwater Management Pond provides enhanced protection (80% TSS) removal. Please refer to the attached Stormwater Management Report for additional details.

10. Sediment and Erosion Control

During construction, silt will be prevented from entering the existing stormwater management ponds and adjacent properties by the use of silt fences along the perimeter of the site. At the construction access points to the site, a mud mat, constructed of crusher run material, will be required to prevent silt from being carried or washed onto adjacent roadways. Straw bale check dams will be placed along nature drainage paths throughout the proposed development. Sediment and Erosion Control measures will be removed once construction is complete, and vegetation has stabilized.

11. Conclusion

This stormwater management report provides a strategy for meeting stormwater quantity control objectives for run-off from the subject site, as well as outlining the required quality control measures.

EXP SERVICES INC.

Prepared by:

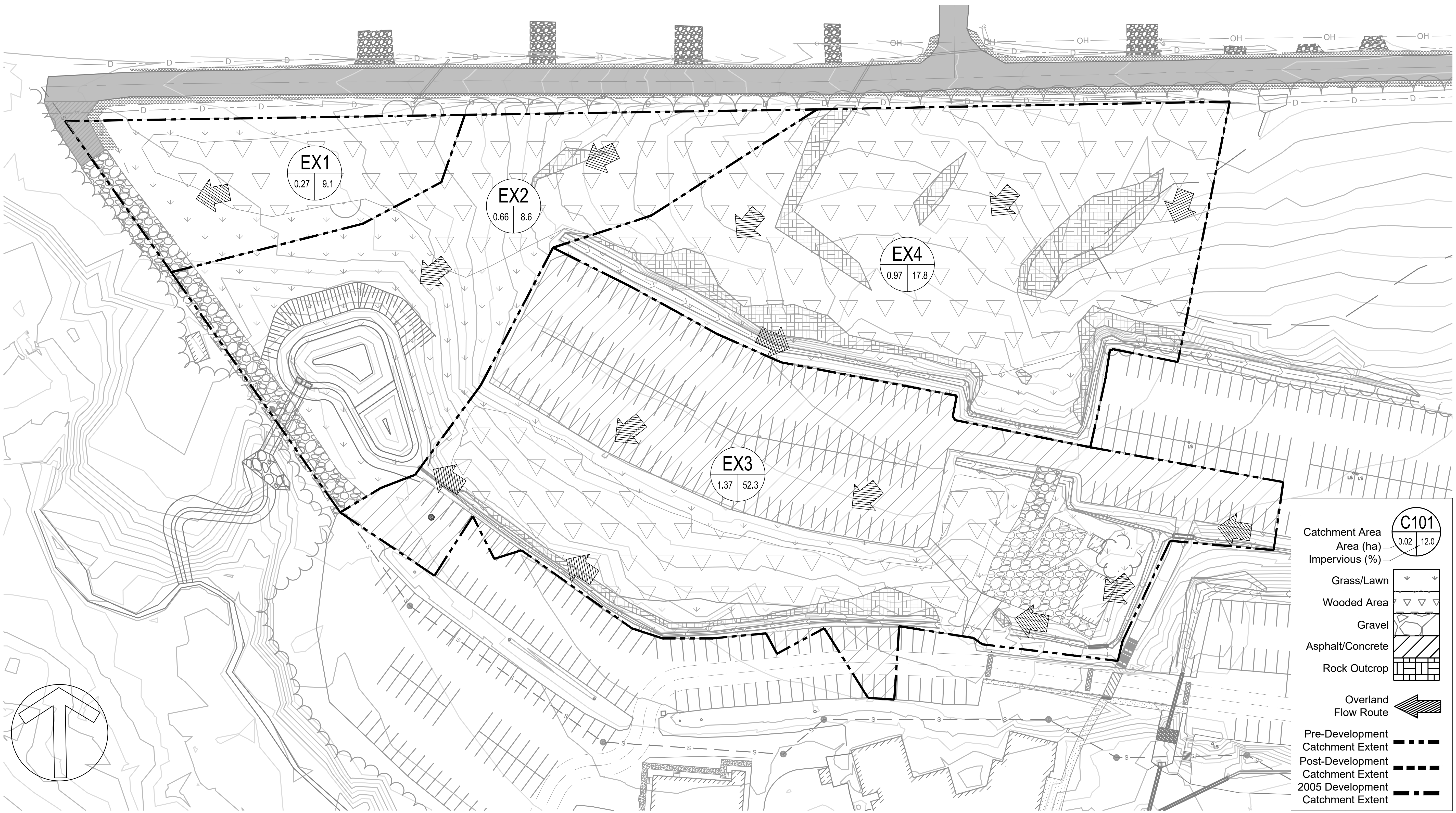
Calvin Caldwell, P.Eng.
Civil Engineer

Reviewed by:

Codey Munshaw, P.Eng.
Civil Engineer

APPENDIX A

PRE-DEVELOPMENT STORMWATER MANAGEMENT PLAN



NO.	DESCRIPTION	DATE	BY	APPROVED
1	PRELIMINARY	DEC 14, 2023	EB	CLC
2	ISSUED FOR SPCA	JULY 8, 2024	BM	CLC

TITLE:

PRE-DEVELOPMENT (CURRENT) STORMWATER MANAGEMENT PLAN

PROJECT:

CANADORE COLLEGE LONG TERM CARE FACILITY

North Bay, ON

CLIENT:

VILLAGES COMMUNITY CARE

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DRAWN:	EB	DESIGN:	CLC	SCALE:	1:1000
PROJECT No.:	NTB-23012663		SWM2		

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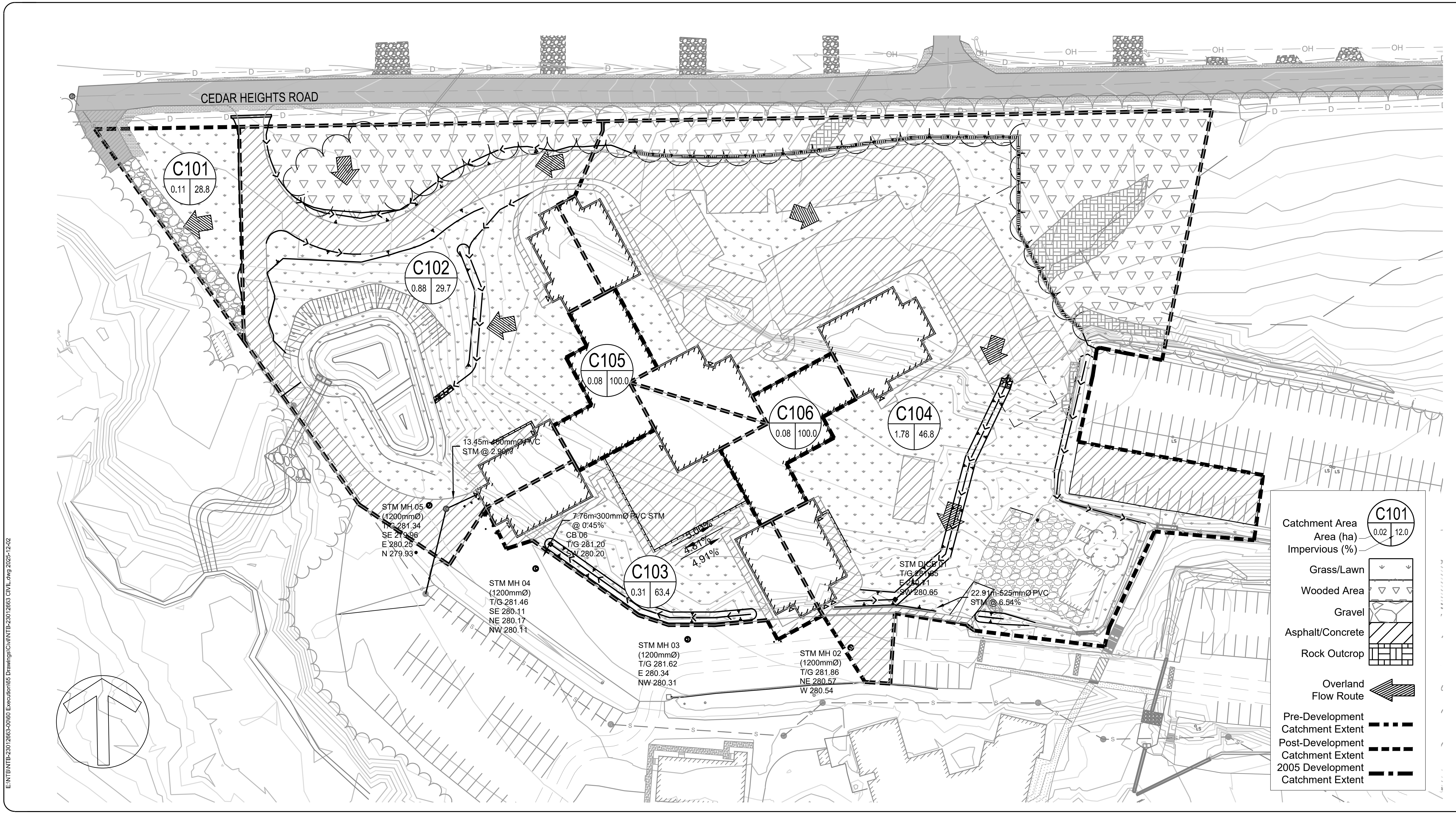
APPENDIX B

POST-DEVELOPMENT STORMWATER MANAGEMENT PLAN



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NO.	DESCRIPTION	DATE	BY	APPROVED
1	PRELIMINARY	DEC 14, 2023	EB	CLC
2	ISSUED FOR SPCA	JULY 8, 2024	BM	CLC

CAUTION: DO NOT SCALE DRAWINGS.

TITLE:
POST-DEVELOPMENT STORMWATER MANAGEMENT PLAN

PROJECT:
CANADORE COLLEGE LONG TERM CARE FACILITY
North Bay, ON

CLIENT:
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DRAWN:	EB	DESIGN:	CLC	SCALE:	1:1000
PROJECT No.:	NTB-23012663		SWM3		

APPENDIX C

MODELING DATA & STORM SEWER DESIGN SHEETS

Weighted Runoff Coefficient

Canadore College LTC

Weighted Runoff Coefficient Calculations

7/9/2024

Area ID	Total Area	0.05 Pond	0.15 Grass	0.30 Woodland	0.60 Gravel	0.80 Rock	0.90 Asphalt/Concrete	0.90 Roof	Weighted Rational Coefficient	Impervious %
Pre-Development	32731	513	8471	13478	1261	1854	7043	111	0.43	31.4
EX-1 (Uncontrolled)	2731	0	1111	1392	181	0	47	0	0.27	8.3
EX-2	6555	513	3081	2444	455	62	0	0	0.24	7.9
EX-3	13683	0	2789	2842	625	320	6996	111	0.61	58.8
EX-4	9762	0	1490	6800	0	1472	0	0	0.35	15.1
Total Controlled (EX-2, EX-3, EX-4)	30000	513	7360	12086	1080	1854	6996	111	0.44	33.5
Post-Development	32431	513	12718	4396	810	745	8641	4608	0.50	45.6
C101 (Uncontrolled)	1128	0	803	0	277	0	48	0	0.29	28.8
C102	8824	513	4150	1540	0	0	2055	566	0.39	29.7
C103	3144	0	1150	0	0	0	1052	942	0.63	63.4
C104	17791	0	6615	2856	533	745	5486	1556	0.51	46.8
C105	772	0	0	0	0	0	0	772	0.90	100.0
C106	772	0	0	0	0	0	0	772	0.90	100.0

Q= 0.0028*C*I*A (cms)
C=RUNOFF COEFFICIENT
I-RAINFALL INTENSITY (10 year)= 885/(Time+5)^0.7632
A=AREA (ha)

STORM SEWER DESIGN

DATE: 9-Jul-24
FILE NTB-23005867
CONTRACT/PROJECT Long Term Care Facility at Canadore College

Catchment Areas	MANHOLE		LENGTH	INCREMENT			TOTAL	FLOW TIME (min)		I	TOTAL Q	S	D	Q FULL	V FULL	COMMENTS
	FROM	TO	(m)	C	A	CA	CA	TO	IN	(mm/h)	(cms)	(%)	(mm)	(cms)	(m/s)	
C104	CBMH 01	STM MH 02	17.8	0.51	1.78	0.91	0.91	10.00	0.22	112.03	0.28	0.45	525	0.29	1.33	
	STM MH 02	STM MH 03	44.1	0.00	0.00	0.00	0.91	10.22	0.55	110.79	0.28	0.45	525	0.29	1.33	
	STM MH03	STM MH 04	45.3	0.00	0.00	0.00	0.91	10.77	0.57	107.81	0.27	0.45	525	0.29	1.33	
	CB	STM MH 04	7.8	0.63	0.31	0.20	0.20	10.00	0.14	112.03	0.06	0.45	300	0.06	0.92	
	STM MH 04	STM MH 05	33.5	0.00	0.00	0.00	1.11	10.77	0.38	107.81	0.33	0.45	600	0.41	1.46	
C105 + C106	Building (Flat Roof)	STM MH 05	12.7	0.90	0.15	0.14	0.14	10.00	0.16	112.03	0.16	0.60	400	0.16	1.28	
	STM MH 05	Pond	18.5	0.00	0.00	0.00	1.25	11.16	0.18	105.86	0.37	0.60	600	0.48	1.68	

SHADED CELLS REQUIRE INPUT FROM USER

Pre-Development NASHYD Model Data

Catchment	Area (ha)	L (m)	S (%)	CN	IA (mm)	RC	t_p (hr)	DT (min)
EX1	0.27	78.8	3.1	62.6	8.5	0.27	0.18	2.2
EX2	0.66	137.5	7.7	62.4	8.4	0.24	0.19	2.2
EX3	1.37	395.1	1.8	80.9	4.9	0.60	0.22	2.6
EX4	0.98	107.9	7.1	58.8	8.5	0.35	0.15	2.0
Total Area	3.27							

Catchment	Wetland/Pond Area (ha)	Granular Area (ha)	Pavement/Roof Area (ha)	Rockland Area (ha)	Woodland Area (ha)	Lawns / Pasture Area (ha)	Weighted CN	Weighted IA (mm)	Weighted RC
EX1	0.000	0.018	0.005	0.000	0.14	0.111	62.6	8.5	0.27
EX2	0.051	0.046	0.000	0.006	0.244	0.308	62.4	8.4	0.24
EX3	0.000	0.063	0.700	0.032	0.284	0.279	80.9	4.9	0.60
EX4	0.000	0.000	0.000	0.147	0.680	0.149	58.8	8.5	0.35

Land Use or Surface	CN	IA (mm)	RC
Wetland/Pond	50	10	0.05
Granular	98	2	0.60
Pavement/Roof	98	2	0.90
Rockland	70	2	0.80
Woodland	55	10	0.30
Lawns / Pasture	65	8	0.15
Light Ind./Com.	98	2	0.50

Post-Development NASHYD Model Data

Catchment	Area (ha)	L (m)	S (%)	CN	IA (mm)	RC	t_p (hr)	DT (min)
C101	0.11	31.8	2.2	74.5	6.3	0.29	0.13	2.0
C102	0.88	92.7	9.3	72.2	6.7	0.39	0.12	2.0
C103	0.31	60.0	12.2	85.9	4.2	0.63	0.03	2.0
C104	1.78	205.0	7.2	77.6	5.5	0.51	0.08	2.0
C105	0.08	22.0	0.5	98.0	2.0	0.90	0.02	2.0
C106	0.08	22.0	0.5	98.0	2.0	0.90	0.02	2.0

Total Area	3.24

Catchment	Wetland/Pond Area (ha)	Granular Area (ha)	Pavement/Roof Area (ha)	Rockland Area (ha)	Woodland Area (ha)	Lawns / Pasture Area (ha)	Weighted CN	Weighted IA (mm)	Weighted RC
C101	0.00	0.03	0.00	0.00	0.00	0.080	74.5	6.3	0.29
C102	0.05	0.00	0.26	0.00	0.15	0.42	72.2	6.7	0.39
C103	0.00	0.00	0.20	0.00	0.00	0.12	85.9	4.2	0.63
C104	0.00	0.05	0.70	0.07	0.29	0.66	77.6	5.5	0.51
C105	0.00	0.00	0.08	0.00	0.00	0.00	98.0	2.0	0.90
C106	0.00	0.00	0.08	0.00	0.00	0.00	98.0	2.0	0.90

Land Use or Surface	CN	IA (mm)	RC
Wetland/Pond	50	10	0.05
Granular	98	2	0.60
Pavement/Roof	98	2	0.90
Rockland	70	2	0.80
Woodland	55	10	0.30
Lawns / Pasture	65	8	0.15
Light Ind./Com.	98	2	0.50

Pre-Development STANDHYD Model Data

Catchment	Area (ha)	XIMP (%)	TIMP (%)	SLPP (%)	LGP (m)	SLPI (%)	LGI (m)	DT (min)
EX1	0.27	1.7	8.3					
EX2	0.66	1.6	7.9					
EX3	1.37	11.6	58.0	2.13	291.00	0.59	125.00	2
EX4	0.98	3.0	15.1					
Total Area	3.27							

Catchment	Wetland/Pond Area (ha)	Granular Area (ha)	Pavement/Roof Area (ha)	Rockland Area (ha)	Woodland Area (ha)	Lawns / Pasture Area (ha)	Weighted RC	Weighted TIMP (%)
EX1	0.00	0.02	0.00	0.00	0.14	0.11	0.27	8.3
EX2	0.05	0.05	0.000	0.01	0.24	0.31	0.24	7.9
EX3	0.00	0.06	0.70	0.03	0.28	0.28	0.60	58.0
EX4	0.00	0.00	0.00	0.15	0.68	0.15	0.35	15.1

Land Use or Surface	RC
Wetland/Pond	0.05
Granular	0.60
Pavement/Roof	0.90
Rockland	0.80
Woodland	0.30
Lawns / Pasture	0.15
Light Ind./Com.	0.50

Post-Development STANDHYD Model Data

Catchment	Area (ha)	XIMP (%)	TIMP (%)	SLPP (%)	LGP (m)	SLPI (%)	LGI (m)	DT (min)
C101	0.11	23.0	28.8	2.4	28	0.0	0	2
C102	0.88	8.9	29.7	5.00	53	2.0	8	2
C103	0.31	19.0	63.4	5.00	20	2.0	60	2
C104	1.78	14.0	46.7	5.00	41	4.0	120	2
C105	0.08	30.0	100.0	1.00	20	1.0	20	2
C106	0.08	30.0	100.0	1.00	20	1.0	20	2
Total Area	1.00							

Catchment	Wetland/Pond Area (ha)	Granular Area (ha)	Pavement/Roof Area (ha)	Rockland Area (ha)	Woodland Area (ha)	Lawns / Pasture Area (ha)	Weighted RC	Weighted TIMP (%)
C101	0.00	0.03	0.00	0.00	0.00	0.08	0.29	28.8
C102	0.05	0.00	0.26	0.00	0.15	0.42	0.39	29.7
C103	0.00	0.00	0.20	0.00	0.00	0.12	0.63	63.4
C104	0.00	0.05	0.70	0.07	0.29	0.66	0.51	46.7
C105	0.00	0.00	0.08	0.00	0.00	0.00	0.90	100.0
C106	0.00	0.00	0.08	0.00	0.00	0.00	0.90	100.0

Land Use or Surface	C
Wetland/Pond	0.05
Granular	0.60
Pavement/Roof	0.90
Rockland	0.80
Woodland	0.30
Lawns / Pasture	0.15
Light Ind./Com.	0.50

APPENDIX D

STORMWATER MANAGEMENT AND POND DRAWINGS

Trow

STORMWATER MANAGEMENT REPORT

Nipissing University, Canadore College

Education Centre

New Construction of Parking Lots

Prepared for:

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Trow Northern Ontario Region

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NORTH BAY, ON, P1B 4V6
Telephone: (705) 474-2720
Facsimile: (705) 474-8515

Project No. NB-08-4966
Date: August 2008

STORMWATER MANAGEMENT REPORT
EDUCATION CENTRE - NEW CONSTRUCTION OF NORTH PARKING LOTS
NORTH BAY, ONTARIO

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1.0 Introduction

This report presents the stormwater management (SWM) plan and recommendations for the proposed Nipissing University and Canadore College, Education Centre's new parking lots. The site is located to the west of College Drive, south of Cedar Heights Road and north of Highway 17 in the City of North Bay. The subject site has a total drainage catchment area of approximately 7.03 ha and contains a few existing maintenance buildings, granular roadways, and vegetated areas with large areas of exposed bedrock (refer to Drawing C-1 in **Appendix M** for the Site Plan). The following sections outline the components of the SWM plan.

2.0 Study Methodology

After a review of available background information and discussions with team members, the following tasks have been undertaken in the preparation of the stormwater management plan for the subject site:

- Review of available previous stormwater management plans;
- Compilation of stormwater management criteria for the site;
- Assessment and verification of the existing drainage conditions through site visits, discussions with the client, the City of North Bay, and the North Bay-Mattawa Conservation Authority (NBMCA) and a review of available topographic information;
- Hydrologic evaluation of the pre-development and proposed development conditions using the computer model PCSWMM 2002;
- Evaluation and recommendations for the stormwater management practices to be implemented;
- Recommendation of appropriate erosion and sediment control measures during construction and until all ground surfaces are stabilized; and,
- Recommendation of appropriate maintenance procedures.

3.0 Required Approvals

Refer to **Table 3.1** for a summary of the required approvals for this project.

Table 3.1: Summary of Required Approvals

Regulatory Agency	Potential Required Approvals	Approval Required for this Project?	Comments
Municipality of North Bay	Site Plan Control Agreement	Yes	
North Bay-Mattawa Conservation Authority	Fill, Construction and Alteration to Waterways Permit	No	
Ministry of the Environment	Municipal and Private Sewage Works Permit Including Stormwater Management Works	No	Subject site does meet the requirements for an approval exemption under regulation O. Reg. 525/98.
Ministry of Natural Resources	Work Permit	No	
Ministry of Transportation	Building and Land Use Permit	No	
Ministry of Transportation	Encroachment Permit	No	

4.0 Information Provided by the Client

The client provided a site plan and a topographic survey of the site. Also, note that the above site plan and survey were used as a base plan for the figures in **Appendix A** and the drawings in **Appendix M**.

5.0 Design Criteria

5.1 Environmental Design Criteria

As outlined in the *Stormwater Management Practices and Design (SWMP) Manual (MOE, March 2003)*, the following are the four general criteria to consider when assessing SWM concerns for a site:

- water balance
- water quality
- in-stream erosion control/geomorphology
- water quantity

Through a review of the site conditions, it was determined that the main concerns were for water quality control, In-Stream Erosion Control/Geomorphology and water quantity control. Refer to **Table 5.1** for a summary of environmental design criteria.

Table 5.1: Summary of Environmental Design Criteria

Design Criteria	Applicable to Subject Site?	Rationale
Water Balance	No	Groundwater recharge is not a concern with development of the site.
Water Quality	Yes	The quality of stormwater discharged from the site is a concern.
In-Stream Erosion Control/Geomorphology	Yes	There is a small watercourse downstream of the site that may benefit from In-Stream Erosion Control.
Water Quantity	Yes	Flooding of downstream properties is a concern.

5.2 Stormwater Management Criteria

The stormwater management criteria were determined through discussions with the City of North Bay and the NBMCA, and are summarized as follows:

- Stormwater Management controls are to be designed using criteria and guidelines included in the *Stormwater Management Practices and Design (SWMP) Manual (MOE, March 2003)*;

Based on the above guidelines, the following criteria were used:

- For water quantity control, post-development flows are not to exceed pre-development flows for the 2-year to 100-year design storms;
- For water quality protection, a wet pond, forebay with extended detention will be designed to accommodate the 2-year to 100-year storm runoff;
- Basic water quality protection is to be provided for the site; and,
- Erosion and sediment controls are to be provided for the site during construction and until all ground surfaces are stabilized.

6.0 Previous Stormwater Management Studies

No known stormwater management studies have been completed for this site.

7.0 Existing Conditions

The following sections outline the pre-development topography and drainage for the site.

7.1 Site Topography

Topographic information for the main site area was obtained from a detailed survey by others with additional survey information recorded by Trow Associates Inc. Under pre-development conditions the main site area (i.e. where development is proposed) has moderate topography, with average slopes in the order of 1-6 percent. The main site area generally slopes towards the west. An existing drainage course drains southerly through the east side of the main site. It should also be noted that north of the site is Cedar Heights Road which has existing developed lots containing single family homes. The main education building is south of the proposed parking lots.

7.2 Site Drainage

Refer to **Figure A.1** in **Appendix A** for the drainage catchment plan showing existing conditions. Site visits were carried out to confirm the site drainage. Generally, the site appears to have been drained in a sheet flow manner. The site (Catchment 1) generally drains towards the west by south-west direction into an existing small manmade drainage course.

7.3 Site Soils Information

Soils information for the site was obtained from the following sources:

- *Soil Survey of Parry Sound District; Report No 31 of the Ontario Soil Survey (Canadian Department of Agriculture and Ontario Department of Agriculture, February, 1962).*

The above report identified that the general soils found in the area of the subject site were a combination (identified as a soil complex in the report) of rock and Wendigo sandy loam. The report indicates that the Wendigo soil series includes sands ranging in size from medium to fine with the inclusion of some coarse sand and gravel.

7.4 Receiving Drainage System Information

7.4.1 Description

The subject site drains to an existing small manmade drainage course that drains into a small watercourse that runs along the west perimeter of the site and flows in a southerly direction. Downstream from the subject site, the watercourse outlets to a large pond or small lake behind the Education Centre.

7.4.2 Known Receiving Drainage System Problems

There are no known receiving drainage system problems. Since the general guideline for stormwater management is to not increase peak flows under post-development conditions, it is not anticipated that, development of the subject site will aggravate any existing drainage problems.

7.5 Floodplain Mapping

There is no floodplain mapping for the drainage course adjacent to the subdivision.

8.0 Stormwater Management Plan (Proposed Conditions)

Refer to **Drawings C-1 and C-5** in **Appendix M** for the SWM Plan layout. The following sections outline the design and calculations for the SWM plan components.

8.1 Water Quantity Control

The general principle for water quantity control is that post-development peak flows are not to exceed pre-development peak flow values. Under post-development conditions, the site will contain three new large paved parking lots, roadways, and vegetated areas. Refer to **Figure A.2** in **Appendix A** for the proposed conditions catchment plan.

In order to determine the runoff characteristics of the site in response to design rainfall events, the hydrologic evaluation for the pre-development and post-development conditions included 2-year to 100-year storm event simulations.

8.1.1 Model Selection

Since it was anticipated that some form of stormwater detention would be required for post-development stormwater management, it was recognized that storage routing would be required and that a hydrographic method should be used.

For the purposes of developing pre-development target flows for the site, as well as modeling post-development storage areas and site outlet peak flows, the computer model PCSWMM 2002 was utilized. PCSWMM 2002 is a graphical user interface for the well-established Storm Water Management Model (SWMM) created by the United States Environmental Protection Agency. This computer model is physically based and has been used extensively throughout Canada and the rest of the world for a wide variety of hydrologic and hydraulic modelling purposes. Refer to **Appendix B** for the PCSWMM 2002 input calculations and refer to the CD in the pocket inside the back cover for the computer modelling input and output files. Also, refer to Figure PCSWMM in **Appendix B** for the PCSWMM model schematic.

8.1.2 Rainfall Input

The subject site is institutional in an urban area, and as indicated in the MTO Drainage Management Manual (1997), the rainfall input storm duration should be in the range of 1 to 6 hours. Since the site will have large impervious areas, the 4-hour Chicago Storm distribution was utilized with a 10 minute time step. The return-period storm distributions were developed using Chicago Storm parameters established by the City of North Bay and the Chicago Storm function of OTTHYMO-89.

8.1.3 Hydrologic Modelling Results

Table 8.1 illustrates the results of the hydrologic modelling for pre-development peak flows and the uncontrolled post-development peak flows for the outlet to the watercourse. Refer to **Figures A.1** and **A.2** in **Appendix A** for the pre and post-development catchment plans.

Table 8.1: Pre-Development and Uncontrolled Post-Development Peak Flows At the Site Outlet to the Watercourse

Design Storm	Pre-Development Peak Flow (m^3/s)	Uncontrolled Post-Development Peak Flow (m^3/s)
PCSWMM ID ->	**RO 1**	**TR-U 51**
2-Year	0.494	0.700
5-Year	0.752	0.922
25-Year	1.253	1.326
100-Year	1.704	1.863

Note: For the above tables, RO=Runoff and TR-U=Transport Uncontrolled

As stated previously, the general principle for water quantity control is that post-development peak flows are not to exceed pre-development peak flow values. The above tables show that under post-development conditions, pre-development peak flow values are exceeded for the site outlet to the watercourse. Therefore, stormwater quantity control measures are required for the site outlet to the watercourse. To address water quantity control requirements, the stormwater management plan will consist of controlling the site's release rate through the use of storage in a stormwater management pond (refer to **Section 9.0** for the pond design).

8.1.4 Uncontrolled Areas

Catchment areas 105 and 107 (**see Figure A.2**) will be released uncontrolled. Catchment 105 will not be developed and existing conditions maintained. Catchment 107 will also be released uncontrolled but will be accounted for by over control from the SWM Pond. Refer to **Section 9.3.1** for Target Flow Development.

8.2 Water Quality Control

The site outlets to a manmade drainage course which drains into a watercourse that may support fisheries that are sensitive to contaminants. Therefore, enhanced protection (the highest level of protection) will be provided for the site. Enhanced protection is used when sensitive aquatic habitat will be impacted by stormwater runoff and requires that 80% long-term removal of suspended solids be achieved.

To address water quality concerns, a wet pond is proposed. Refer to **Section 9.1** for the wet pond water quality control design.

8.3 Stormwater Conveyance System (Major/Minor System)

8.3.1 Culverts

There are five culverts proposed for the site (numbers 1-5), which have been designed to capture flows up to and including the 100-year storm. There are also three existing culverts (6, 7 and 8) that convey flows up to the 25-year storm event. Refer to **Appendix C** for Culvert and Ditch Design Report sheets also refer to **Figure A.2** in **Appendix A** for the locations.

8.3.2 Ditches

Swales and ditches will also be used to convey stormwater runoff from parking lots; these swales and ditches will have capacity to convey runoff from the 100-year storm. Haestad Methods' Flow Master computer program was used to design the swales and ditches. Refer to **Appendix C** for the design and calculations also refer to **Drawing C-3** in **Appendix M** for the ditch section locations.

8.3.3 Channel Erosion Protection Requirements and Riprap Design

The swales and ditches discussed in **Section 8.3.2** were confirmed for channel erosion protection requirements. As outlined in the Chapter 5 of the MTO Drainage Management Manual, the Maximum Permissible Tractive Force methodology was used for the analysis. In general, the methodology calculates the shear force exerted by the flow on the channel surfaces, and compares that force to the resistive forces holding the channel material to the channel surface. If the shear force is greater than the resistive force, erosion will occur.

Refer to **Appendix D** for calculations confirming the channel erosion protection requirements. In general, each channel was initially assumed to have a grass channel lining. If it was determined that erosion would occur during the required design storm, riprap protection was designed for the channel.

Based on the results of the analysis, riprap channel lining will be required to provide sufficient erosion protection for all swales and ditches for the subject site.

9.0 SWM Pond Design

A wet pond is proposed for the SWM plan. The following sections outline the design components of the SWM pond. Refer to **Figure A.2** in **Appendix A** for the proposed conditions catchment plan.

9.1 Water Quality Design

Water quality protection for areas tributary to the wet pond will be provided by storage in the facility. The following sections outline the water quality design components of the site's SWM plan.

9.1.1 Pond Storage Requirements

Water quality protection for the removal of suspended solids in detention facilities is based on the provision of a specific volume of water for suspended solids to settle out. A wet pond is proposed for the SWM plan. Table 3.2 in the SWMP Manual outlines the unit water quality storage requirements based upon a site's imperviousness level and the required level of protection. As stated previously, enhanced protection (80% long-term removal of suspended solids) will be provided for the site.

Based on the imperviousness of each drainage area, the unit storage values in Table 3.2 of the SWMP Manual were used to determine the required water quality storage volume for the site. As stated in the SWMP Manual, 40 m^3/ha of the required value for a wet pond represents extended detention storage, while the balance of the unit storage value represents permanent pool storage.

Refer to **Table 9.1** for an outline of the required storage volume and refer to **Appendix E** for calculations of the water quality storage requirements.

Table 9.1: Water Quality Control Storage Requirements

Pond Component	Wet Pond 1
Tributary Area (ha)	4.54
Imperviousness (%)	62
Imperviousness Used (%)	62.5
Permanent Pool Unit Storage Required (m^3/ha)	167
Extended Detention Unit Storage Required (m^3/ha)	40
Total Unit Storage Required (m^3/ha)	207
Permanent Pool Storage Required (m^3)	758
Extended Detention Storage Required (m^3)	182
Total Storage Required (m^3)	940

As stated previously, since the SWM pond will be a wet facility, the extended detention portion will be the greater of the erosion control volume requirement and the water quality control requirement. Refer to **Section 9.2** for the design of the extended detention component of the SWM pond.

9.1.2 Forebay Design

A forebay was incorporated into the wet pond to improve pollutant removal and to minimize the potential for re-suspension of sediment. To minimize the potential for re-suspension, a minimum forebay depth of 1.0 m is recommended in the SWMP Manual. Two calculations are used to size the forebay: the settling length and the dispersion length. Refer to **Appendix F** for the forebay design and calculations.

The settling calculation determines the distance to settle out a certain size of sediment. The method presented in the SWMP Manual assumes that the velocity through the forebay is dictated by the flow rate out of the pond. As recommended in the SWMP Manual, a 4-hr 25-mm Chicago design storm was used to determine a pond outflow for settling length calculations. Equation 4.5 from the SWMP Manual was used for the calculation, which is as follows:

$$Dist = (r * Q_P / V_S)^{0.5}$$

where,	Dist	=	forebay length (m)
	r	=	length-to-width ratio of forebay
	Q_P	=	peak flow rate from the pond (m^3/s)
	V_S	=	settling velocity (m/s) (dependant on desired particle size to settle - SWMP Manual recommends a value of 0.0003 m/s)

The dispersion length calculation determines the distance through the forebay that is required to slow down the pipe inflow into the pond. The SWMP Manual recommends that the pipe discharge should be slowed down to a maximum velocity of 0.5 m/s at the forebay berm. Equation 4.6 from the SWMP Manual was used for the calculation, which is as follows:

$$Dist = (8 * Q) / (d * V_f)$$

where,	Dist	=	length of dispersion (m)
	Q	=	inlet flow rate (m^3/s)
	d	=	depth of permanent pool in forebay (m)
	V_f	=	desired velocity in forebay (m/s)

A forebay berm will be provided to separate the forebay from the rest of the wet pond.

The forebay berm will be submerged and will be approximately 0.10 m below the permanent pool water level. A submerged berm has the advantages that it will avoid the need for conveyance pipes from the forebay to the main pond cell, as well as the safety benefit that the public will not be tempted to walk on the berm. The forebay berm will be lined with riprap for stabilization purposes.

Refer to **Table 9.2** for a summary of the design characteristics of the wet pond forebay.

Table 9.2: Summary of Forebay Design Characteristics

Design Element	Pond 1
Depth	1.53 m
Length-to-Width Ratio	2:1
Settling Length	9 m
Dispersion Length	13 m
Minimum Bottom Width	1 m
25-mm Storm Average Flow Velocity	0.09 m/s

As recommended in the MOE SWMP Manual, a check of the average velocity in the forebay during a 25-mm design storm was undertaken. The SWMP Manual indicates that the empirically recognized maximum permissible velocity before channel erosion will occur is 0.15 m/s, and therefore, the average velocity in the forebay should be less than or equal to 0.15 m/s. The average flow velocity during a 25-mm design storm was determined to be below the maximum permissible velocity, and therefore erosion is not anticipated in the forebay during a 25-mm event (refer to **Table 9.2**). Refer to **Appendix F** for the forebay flow velocity calculations.

9.2 Extended Detention Design

For wet facilities, the extended detention component of the pond is based upon the greater of the erosion control active storage or the water quality active storage. As indicated in the SWMP Manual, providing both types is normally not necessary due to the similar drawdown characteristics of each type of storage. Refer to **Table 9.3** for a summary of the erosion control and water quality volume requirements, as well as the extended detention volume, which was taken as the greater of the two.

Table 9.3: Summary of Extended Detention Volumes

Design Element	Wet Pond
Erosion Control	382
Water Quality	182
Extended Detention	382

9.2.1 Extended Detention Outlet Design

For the design of an extended detention outlet, typically the outlet control device is sized so that the extended detention storage volume (refer to **Section 9.2**) is drawn down over 24 hours, unless the outlet is susceptible to clogging due to its size. In that case, a minimum 12-hour detention time is allowed.

To control outflow from the extended detention portion of the pond, a culvert orifice pipe will be used in the outlet. A spreadsheet was used to size the required orifice and to develop the headwater-discharge rating curve for the pond. Refer to **Appendix I** for the orifice design and calculations, and refer to **Table 9.4** for a summary of the orifice design.

Table 9.4: Summary of Wet Pond Extended Detention Orifice Designs

Design Element	Diameter (mm)	Invert Elev. (m)
Orifice 1-1	200	279.850

9.2.2 Extended Detention Drawdown Time

Refer to **Appendix G** for drawdown time calculations and refer to **Table 9.5** for a summary of the extended detention drawdown time.

Table 9.5: Summary of Extended Detention Drawdown Time

	Pond
Drawdown Time (hr)	29

An orifice diameter of 200 mm was used in the design of the extended detention outlet and a 24-hour drawdown time was achieved.

9.3 Water Quantity Design

As indicated in **Section 8.1**, the general principle for water quantity control is that post-development peak flows are not to exceed pre-development peak flow values. For the SWM pond design, storage will be used to control the 2-year to 100-year post-development storm events to pre-development levels.

9.3.1 Target Flow Development

A storage facility will be used for stormwater management for the site. In general, under pre-development conditions, Catchment 1 contained the areas that will drain to the SWM pond under post-development conditions. Therefore, the results of the pre-development flows of Catchment 1 minus Post-Uncontrolled Catchment 107 were used as the target flows for the SWM pond.

Refer to **Appendix H** for target flow calculations and refer to **Table 9.6** for a summary of target flows for the SWM pond.

Table 9.6: SWM Pond Target Flows (m^3/s)

Design Storm	Pond
2-Year	0.483
5-Year	0.720
25-Year	1.200
100-Year	1.588

9.3.2 Active Storage Area Design Components

The active storage area design will consist of appropriate grading to provide sufficient storage volume to attenuate post-development peak flows. For the wet SWM pond, the active storage component will incorporate the extended detention component. Refer to **Appendix E** for the pond rating curve design and calculations.

To add a measure of permanency to the pond outlet control, an orifice pipe will be used for the pond outlet. Other devices such as orifice plates or inlet control devices are easier to remove, when compared with an orifice pipe. The minimum diameter available for sewer pipe is 100 mm, however the diameter for the orifice pipes was restricted to 200 mm, which meets the preferred criteria in the SWMP Manual.

Similar to the design of the extended detention portion of the wet pond, a spreadsheet was used to size the required orifices and to develop the headwater-discharge rating curves for the pond. Refer to **Appendix I** for the orifice designs and calculations, and refer to **Table 9.7** for a summary of the orifice designs.

Table 9.7: Active Storage Outlet Control Design

Control ID	Outlet Control Invert Elevation (m)	Outlet Control Diameter or Length (mm or m)
Orifice 1-1	279.85	200
Orifice 1-2	280.30	900
Orifice 1-3	280.15	900

9.3.3 Summary of Storage Volumes and Release Rates

Refer to **Table 9.8** and **Table 9.9** for a summary of storage volumes and release rates at the outlet of the pond and at the existing watercourse. Refer to **Appendix B** for the PCSWMM 2002 input calculations and refer to the CD in the pocket inside the back cover for the computer modelling input and output files.

Table 9.8: Storage Volumes and Release Rates at the Outlet of Pond

Design Storm	Target Flow (m^3/s)	Uncontrolled Post-Development Peak Flow (m^3/s)	Storage Required (m^3)	Storage Used (m^3)	Controlled Post-Development Peak Flow (m^3/s)
SWMM ID->		**TR-U 200**	**TR-I**		**TR-C 200**
2-Year	0.483	0.615	441	705	0.028
5-Year	0.720	0.874	482	864	0.070
25-Year	1.200	1.301	536	1102	0.163
100-Year	1.588	1.805	572	1323	0.304

Note: For the Storage required column, the pond rating curve in TR-I was iterated until the modelled pond outflow (TR-I 107) met the target flow (RO 30)

Table 9.9: Release Rates at the Site Outlet to the Watercourse

Design Storm	Pre-Development Peak Flow (m^3/s)	Uncontrolled Post-Development Peak Flow (m^3/s)	Controlled Post-Development Peak Flow (m^3/s)
SWMM ID->	**RO 1**	**TR-U 51**	**TR-C 51**
2-Year	0.494	0.700	0.072
5-Year	0.752	0.922	0.173
25-Year	1.253	1.326	0.353
100-Year	1.704	1.863	0.532

Note: For the above tables, RO=Runoff, TR-U=Transport Uncontrolled, TR-I=Transport Ideal Pond, and TR-C=Transport Controlled

9.3.4 Emergency Overflow Outlets

In the event of blockage of the wet pond's outflow control orifices, an emergency overflow outlet has been provided in with capacity for the uncontrolled 100-year peak flow, which assumes complete blockage of the orifice outlets. Refer to **Table 9.10** for a summary of the overflow outlet type and characteristics.

Table 9.10: Emergency Overflow Weir Design Features

Design Component	Pond
Overflow Outlet Type	Weir
Design Discharge (m^3/s)	1.704
Invert Elevation (m)	280.350
Design Flow Depth (m)	0.42
Erosion Protection	450mm Riprap

Refer to **Appendix J** for the emergency overflow outlet design and calculations and refer to **Appendix D** for the erosion protection design and calculations.

9.3.5 Summary of Pond Configuration

Refer to **Table 9.11** for a summary of the proposed characteristics for the SWM pond.

Table 9.11: Summary of SWM Pond Characteristics

Design Element	Required	Provided
Drainage Area	4.83 ha	4.54 ha
Extended Detention Treatment Volume (Max Required for Erosion Control)	382 m^3	426 m^3
Permanent Pool Volume	758 m^3	839 m^3
Extended Detention Storage	24 hour drawdown	29 hour drawdown
Forebay	Min 1.0 m deep	1.53 m deep
Forebay Length to Width Ratio	2:1	2:1
Overall Length to Width Ratio	3:1	3:1
Permanent Pool Depth	Mean Depth 1-2 m	1.53 m
Extended Detention Depth	Max 1.5 m	0.30 m
Total Active Storage Depth	Max 2.0 m	0.40 m
Side Slopes	5:1 for 3 m on either side of the permanent pool, 3:1 elsewhere 3:1 for the forebay berm	5:1 for 3 m on either side of the permanent pool, 3:1 elsewhere 3:1 for the forebay berm

Design Element	Required	Provided
Emergency Overflow Outlet	-	Sized for uncontrolled 100-yr inflow
Inlet	-	1 inlet ditch
Outlet Controls	-	3 orifice pipes

9.3.6 Sediment Cleanout Frequency

Over time, the total suspended solids (TSS) removal efficiency of a pond decreases due to the accumulation of solids in the pond. The allowable reduction in TSS removal efficiency is 5 percent. For enhanced water quality protection, the initial TSS removal efficiency is 80%, therefore the target maintenance TSS removal efficiency is 75 percent. The decrease in TSS removal efficiency for the wet pond was calculated on an annual basis using the sediment loadings given in Table 6.3 of the SWMP Manual. Refer to
Table 9.12 for a summary of removal efficiencies and the required maintenance frequencies, and refer to **Appendix K** for sediment accumulation and maintenance frequency calculations.

Table 9.12: Wet Pond Sediment Cleanout Frequencies

Design Component	Pond
Initial TSS Removal Efficiency (%)	100
Final TSS Removal Efficiency (%)	75
Maintenance Frequency (yr)	69

9.3.7 Maintenance Drawdown

If drawdown of a pond is required for maintenance purposes, it is recommended that drawdown not be undertaken in the early spring. As indicated in the SWMP Manual, this will help avoid discharge of water with low oxygen levels or high chloride levels.

A maintenance drain could not be provided for the SWM pond since the pond bottom will be below the elevation of the watercourse that the pond outlets to. Therefore, in order to draw down the pond for maintenance, the pond water will need to be pumped out.

9.3.8 Plantings

The SWMP Manual designates five types of plantings that are implemented for SWM facilities. These are: deep water, shallow water, shoreline fringe, flood fringe, and upland plantings. Appendix H of the SWMP Manual provides a list of appropriate plant species for each of the five types of planting areas. Refer to **Table 9.13** for a summary of the wet pond planting zones and recommended planting species. The recommended plantings to be used in and around the SWM ponds were determined using guidance from *Section 4.6.1 SWMP Vegetation* of the SWMP Manual.

Table 9.13: Summary of Wet Pond Planting Zones

Planting Zone	Location	Pond Elevation Range	Comment	Recommended Planting Species
Deep Water	Permanent pool where the depth > 0.50m.	278.32m to 279.55m	Some emergent species (e.g. cattail and bulrush) may tolerate water depths greater than 0.50m.	No plantings. Allow succession to vegetate this area.
Shallow Water	Permanent pool where the depth is approximately 0.30m.	279.55m to 279.85m	Potential West Nile Virus issues.	Mixture of cattails and bulrushes planted at a density of 2 metre centres (i.e. 1 plant per 4 m^2 area). The plants should be planted in a checkerboard pattern.
Shoreline Fringe	Land between permanent pool and erosion/water quality control storage high water mark.	279.85m to 280.25m	Potential West Nile Virus issues.	Lowland Grass Seed Mixture as per OPSS 572
Flood Fringe	Land between shoreline fringe and 100-year storage high water mark.	280.25m to 280.60m	As a safety feature and an alternative to fencing, thorny vegetation can be planted in this zone to act as a barrier to casual entry to the pond.	Grass Seed Mixture as per OPSS 572. If desired, supplemented with thorny bushes for safety barrier.

Planting Zone	Location	Pond Elevation Range	Comment	Recommended Planting Species
Upland	Above flood fringe area.	280.60m to 280.77m	Landscaped area provided as aesthetic amenities around the pond.	Grass Seed Mixture as per OPSS 572. If desired, supplemented with native trees, bushes, and shrubs.

It should be noted that the following is indicated on page 4-47 of the SWMP Manual:

> *Vegetation communities are dynamic, evolving over time to adapt to the changing environment. Planting design must recognise this evolutionary process to ensure that objectives are achieved over the long term.*
>
> *Limited monitoring results show that species may shift from those planted to those which are more locally successful, particularly within pools and frequently inundated areas. Planting strategies are important in ensuring effective SWMP operation; however, they do not need to be overly complex since natural succession plays an important role in the ultimate make-up of the vegetation community.*

Based on the above, a practical planting strategy would include initial stabilization of the pond using native plant species such as bulrushes and cattails within the shallow water area of the pond, as well as appropriate grass seed mixtures for areas above the shoreline.

The shallow water vegetation should be planted at a density of 2 metre centres (i.e. 1 plant per 4 m^2 area), and should be planted in a checkerboard pattern. Cattails and bulrushes species should be those native to northern Ontario (i.e. for cattails use Typha Latifolia, and for bulrushes use Scirpus Cyperinaus, Scirpus Atrovirens, or Scirpus Rubrotinoctus). The mix of plantings should be approximately 80% cattails and 20% bulrushes. Additional guidance on establishing aquatic plants can be found in Environment Canada's document *Planting the Seed, A Guide to Establishing Aquatic Plants*, which is currently available in digital format on their website.

Additional plantings can be included in the upper areas above the shoreline to improve the aesthetics and safety of the pond. During the regular maintenance inspections of the pond, the vegetation should be monitored to ensure that the vegetation has been established and to document the occurrence of natural succession.

9.4 Safety Concerns

9.4.1 Pond Grading

To minimize the potential for a person to fall into the wet pond, terraced grading will be used. With terraced grading, the side slope of a pond is alternated between steep and gentle slopes. A side slope of 5:1 was used for 3 m horizontally on either side of the permanent pool level, and above and below this gently sloped zone, a maximum slope of 3:1 was used.

9.4.2 Pond Access

Due to the potential for liability issues, it is recommended that a reasonable barrier be created around the wet pond in order to keep the public out. Since a chain link fence may not be desirable for aesthetic reasons or for safety concerns such as entrapment of trespassers, other barriers may be considered such as strategic planting of thorn bearing trees and shrubs. Refer to **Section 9.3.8** for the appropriate planting location for the thorn bearing vegetation. For areas where barrier vegetation is used, temporary fencing may be required until the vegetation matures and provides an effective barrier.

9.4.3 Signage

Signs should be installed around the pond to inform the public about the purpose and function of the ponds and the potential for water level fluctuations in the pond during storm events. Refer to **Appendix L** for Stormwater Management Sign.

10.0 Erosion and Sediment Control

Prior to the commencement of construction, the contractor is to prepare an erosion and sediment control plan to the satisfaction of the engineer.

11.0 SWM Maintenance

As indicated in the SWMP Manual, maintenance is a key task for the effective performance of SWM practices, and in the past, lack of maintenance has resulted in the failure and/or poor performance of SWM practices. The SWMP Manual recommends that an annual maintenance report be prepared that outlines the maintenance activities, the observations from inspections, and recommendations for inspection and maintenance activities for the coming year.

The following sections outline the maintenance activities recommended for this SWM plan.

11.1 Inspections

During the first two years of operation, the SWMP Manual recommends that inspections of SWM facilities be carried out after every significant storm, which normally occurs four times a year. This ensures that the SWM facilities are functioning properly. If during the initial two-year period the SWM facilities are confirmed to function properly, inspections may be reduced to once per year.

The site's catchbasins should be monitored periodically to check for accumulation of sediment, as well as trash/debris that might block the outlets. To ensure the proper functioning of the catchbasins, this accumulation and trash/debris should be removed. The main period for trash/debris removal is during the spring, but should also be carried out periodically when observed during regular inspections.

11.2 Winter Catchbasin Maintenance

Under winter conditions, the outlets of the site's catchbasins might become blocked by snow and ice. During regular snow removal from the site, snow should be cleared from the catchbasin grates so that the catchbasins can be easily located as well as to facilitate access to the catchbasin. Prior to the spring melt, any ice and snow blockages in the catchbasins should be removed.

11.3 Grass Cutting

The SWMP Manual recommends that grass cutting around SWM facilities should be limited or eliminated. Longer grass enhances water quality and deters nuisance species (such as geese) from habitating around SWM facilities. If grass cutting will occur on the site to enhance the aesthetic qualities of the property, grass cutting should be carried out as infrequently as possible.

For wet pond facilities, the following items are recommended in the SWMP Manual and should be considered when cutting grass:

- grass should not be cut to the edge of the permanent pool;
- for safety reasons, cutting should be carried out in a direction parallel to the shoreline; and,
- to reduce organic loadings in the facility, grass clippings should be ejected upland.

11.4 Weed Control

The SWMP Manual recommends that weed control be carried out by hand to prevent the destruction of the surrounding vegetation. It also recommends that due to the potential for water quality problems, the use of herbicides and insecticides should be prohibited near SWM facilities. Also, to minimize the nutrient loading on downstream receiving waters, the use of fertilizers should be limited.

11.5 Plantings

Refer to **Section 9.3.8** for a discussion on plantings. Generally, there are five types of plantings that are implemented for SWM facilities: deep water, shallow water, shoreline fringe, flood fringe, and upland plantings.

The shallow water plantings are those that are along the immediate shoreline and within the permanent pool of water, and the shoreline fringe plantings are those that are exposed to frequent wetting and drying as a result of storm events that raise the water level in a SWM facility. The shallow water and shoreline fringe plantings are the hardest to establish and will likely require maintenance (such as replanting or enhancement) during the first two years of operation. The required plantings for these zones should be confirmed prior to maintenance.

The flood fringe and upland plantings are those that are above the regular wetting zone of the SWM facility and are usually stable and do not require much maintenance.

11.6 Trash Removal

Trash and debris removal is required for all SWM practices, especially at the outlets of the SWM facilities. The main period for trash removal is during the spring, but should also be carried out periodically when observed during regular inspections.

11.7 Sediment Removal

The frequency for sediment removal is dependant up the type of SWM practice and the design characteristics of the SWM practice. The following sections outline the frequencies and methods for sediment removal from the various types of SWM facilities.

11.7.1 Grassed Swales and Ditches

The need for sediment removal in grassed swales and ditches will be determined by visual inspection and by the aesthetic qualities of the ditch.

11.7.2 Wet Ponds

The maintenance frequency for the SWM ponds was discussed in **Section 9.3.6**. To remove sediment from the SWM pond, standard grading and excavation equipment should be used, such as backhoes and excavators. Care should be taken during the sediment removal so that SWM features of the facility are not altered or destroyed.

It is recommended that *The Stormwater Management Facility Sediment Maintenance Guide (Greenland International Consulting Inc., 1999)* be consulted prior to sediment cleanout. It should also be noted that, as indicated in **Section 9.3.7**, to avoid discharge of water with low oxygen levels or high chloride levels, drawdown should not be undertaken in the early spring.

11.7.3 Haulage of Un-Dewatered Sediment

As indicated in the SWMP Manual, sediment should be removed from the site without migration of sediment to roads, stormwater conveyance systems, or watercourses. Since it is unlikely that a sediment drying area will be available, the sediment removed from the wet SWM pond will likely be un-dewatered. Sediment that is un-dewatered will potentially leak out from conventional dump trucks and deposit sediment on the roadways that it traverses. In this manner, the vehicles that will transport the un-dewatered sediment will need to be leak-proof.

Based on the SWM pond maintenance frequencies outlined in **Section 9.3.6**, it is anticipated that sediment removal will not be required for at least 69 years. Since it is unknown what regulations and guidelines will be in place at that time for the haulage of un-dewatered sediment, it is not appropriate at this time to comment on any additional requirements for haulage of un-dewatered sediment. Generally, the contractor undertaking the maintenance should abide by the regulations and guidelines that are current at the time of maintenance, and should also confirm that the requirements of the municipality are also met.

11.7.4 Sediment Disposal

As indicated in the SWMP Manual, the sediment removed from SWM facilities will generally not be classified as hazardous waste due to the contaminants in the sediment, but it is still necessary to have the sediment tested prior to disposal to determine the sediment disposal requirements. The SWMP Manual indicates that most private laboratories are familiar with the MOE sediment disposal requirements and are able to test the sediment for appropriate parameters and determine the acceptable disposal options.

12.0 Closing Remarks

Based on the discussions above, the following conclusions are provided:

1. The stormwater management plan and recommendations will meet the water quality control, in-stream erosion control/geomorphology, and water quantity control requirements for the site.
2. Regular maintenance will ensure the long-term effectiveness of the stormwater management plan.

Should you require additional information or clarification on the material submitted for review, please do not hesitate to contact us.

Prepared by,
TROW ASSOCIATES INC.
Trow Northern Ontario Region

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August 19, 2008

Reviewed by,

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APPENDIX A
Figures

APPENDIX B
PCSWMM 2002 Input/Output

Environment Canada IDF Values and Chicago Storm Parameters

	Return Period Average Rainfall Intensities (mm/hr)[1]						
Duration(min)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Duration
5	99.6	138.0	164.4	196.8	220.8	244.8	5 min
10	72.0	95.4	111.6	131.4	146.4	160.8	10 min
15	58.8	76.8	88.8	104.0	115.2	126.8	15 min
30	39.4	51.0	58.6	68.4	75.6	82.6	30 min
60	24.5	32.8	38.3	45.2	50.3	55.4	1 hr
120	15.1	19.8	23.0	27.0	30.0	33.0	2 hr
360	6.9	8.6	9.8	11.2	12.3	13.4	6 hr
720	4.1	5.3	6.0	7.0	7.7	8.5	12 hr
1440	2.3	2.9	3.3	3.9	4.2	4.6	24 hr

[1] Based on Environment Canada IDF values for North Bay (1986)

	Return Period Rainfall Depths (mm)[2]						
Duration(min)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Duration
5	8.3	11.5	13.7	16.4	18.4	20.4	5 min
10	12.0	15.9	18.6	21.9	24.4	26.8	10 min
15	14.7	19.2	22.2	26.0	28.8	31.7	15 min
30	19.7	25.5	29.3	34.2	37.8	41.3	30 min
60	24.5	32.8	38.3	45.2	50.3	55.4	1 hr
120	30.1	39.6	46.0	54.0	60.0	65.9	2 hr
360	41.2	51.7	58.6	67.4	73.9	80.4	6 hr
720	49.1	63.1	72.4	84.1	92.8	101.5	12 hr
1440	55.3	70.2	80.1	92.5	101.8	111.0	24 hr

[2] (Return Period Rainfall Depth) = (Return Period Average Rainfall Intensity)/Duration * (60min/1hr)

	Return Period Chicago Storm Parameters (mm/hr)					
	2-yr[3]	5-yr	10-yr	25-yr	50-yr	100-yr
a	602.9	771.2	904	1030.1	1177.5	1283.1
b	6.03	4.91	4.7	4.2	4.3	4.14
c	0.762	0.762	0.766	0.762	0.769	0.768

[3] 2-yr a,b,c values determined using 1986 IDF values and the Chicago Storm function of OTTHYMO-89

Note: All other a,b,c values determined by B.F. Dawdy

	Return Period Average Rainfall Intensities (mm/hr)[4]						
Duration(min)	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	Duration
5	96.8	134.3	158.6	189.9	211.9	234.6	5 min
10	72.8	98.4	115.3	136.4	152.2	167.8	10 min
15	59.2	78.9	92.2	108.4	120.9	133.0	15 min
30	39.3	51.5	59.7	69.8	77.7	85.3	30 min
60	24.8	32.1	37.1	43.2	47.9	52.5	1 hr
120	15.1	19.5	22.4	26.1	28.9	31.6	2 hr
360	6.7	8.6	9.9	11.5	12.6	13.8	6 hr
720	4.0	5.1	5.8	6.8	7.4	8.2	12 hr
1440	2.4	3.0	3.4	4.0	4.4	4.8	24 hr

[4] Based on Return Period Chicago Storm Parameters and average intensity equation { $i = a/(td + b)^c$ }

4-hr Chicago Storm Distributions for North Bay
(Based on City of North Bay IDF Data)

2-yr depth: 36.46
25-mm convert: 0.69
Rtrn Per: 25-mm*
Duration: 4-hr
Time Step: 10 min
r: 0.45

Time (min)	Rainfall Intensity (mm/hr)
0	1.71
10	1.87
20	2.06
30	2.31
40	2.63
50	3.09
60	3.76
70	4.88
80	7.18
90	14.89
100	50.10
110	16.02
120	8.23
130	5.67
140	4.38
150	3.61
160	3.09
170	2.70
180	2.41
190	2.19
200	2.01
210	1.86
220	1.73
230	1.62
Average=	**6.25**

Rtrn Per: 2-yr
Duration: 4-hr
Time Step: 10 min
r: 0.45

Time (min)	Rainfall Intensity (mm/hr)
0	2.50
10	2.73
20	3.01
30	3.37
40	3.84
50	4.50
60	5.48
70	7.12
80	10.47
90	21.72
100	73.06
110	23.36
120	12.00
130	8.27
140	6.39
150	5.26
160	4.50
170	3.94
180	3.52
190	3.20
200	2.93
210	2.71
220	2.52
230	2.36
Average=	**9.12**

Rtrn Per: 5-yr
Duration: 4-hr
Time Step: 10 min
r: 0.45

Time (min)	Rainfall Intensity (mm/hr)
0	3.13
10	3.42
20	3.77
30	4.21
40	4.80
50	5.62
60	6.84
70	8.88
80	13.07
90	27.32
100	98.08
110	29.41
120	14.98
130	10.31
140	7.98
150	6.57
160	5.62
170	4.93
180	4.41
190	4.00
200	3.66
210	3.39
220	3.15
230	2.96
Average=	**11.69**

Rtrn Per: 25-yr
Duration: 4-hr
Time Step: 10 min
r: 0.45

Time (min)	Rainfall Intensity (mm/hr)
0	4.13
10	4.51
20	4.97
30	5.55
40	6.32
50	7.39
60	8.98
70	11.62
80	17.05
90	35.69
100	136.04
110	38.44
120	19.53
130	13.48
140	10.45
150	8.62
160	7.38
170	6.49
180	5.80
190	5.27
200	4.83
210	4.47
220	4.16
230	3.90
Average=	**15.63**

Rtrn Per: 100-yr
Duration: 4-hr
Time Step: 10 min
r: 0.45

Time (min)	Rainfall Intensity (mm/hr)
0	4.87
10	5.31
20	5.86
30	6.56
40	7.48
50	8.75
60	10.65
70	13.83
80	20.37
90	43.05
100	167.27
110	46.41
120	23.38
130	16.07
140	12.43
150	10.23
160	8.74
170	7.67
180	6.86
190	6.22
200	5.70
210	5.27
220	4.90
230	4.59
Average=	**18.85**

Sub-Catchment Width Calculations

Scenario	Sub-Catch ID	Main Drainage Channel Length (m)	Estimated Skew Factor*	Sub-Catch Width** (m)	Comment
Pre	1	391	1.00	391	
Post	101	70	1.00	70	
Post	102	125	1.00	125	
Post	103	130	1.00	130	
Post	104	185	1.00	185	
Post	105	290	1.00	290	
Post	106	172	1.00	172	
Post	107	65	1.00	65	

* skew = $(A_2-A_1)/A_{TOT}$
i.e. 0.0 skew = equal catchment areas on either side of the main drainage channel - 1.0 skew = entire catchment area on one side of the main drainage channel.

** sub-catchment width = (2-skew)*L

Detailed Catchment Areas

Pre-Development Areas (Fig. A.1)

Location	Catchment ID	Total Area (m^2)	Total Area (ha)	Pervious Area (m^2)	Pervious Area (ha)	Impervious Area (m^2)	Impervious Area (ha)	Impervious Percent (%)
	1	70,290	7.03	50,706	5.07	19,584	1.96	28
		70,290	7.03	50,706	5.07	19,584	1.96	28

Post-Development Areas (Fig. A.2)

Location	Catchment ID	Total Area (m^2)	Total Area (ha)	Pervious Area (m^2)	Pervious Area (ha)	Impervious Area (m^2)	Impervious Area (ha)	Impervious Percent (%)
	101	11,031	1.10	9,503	0.95	1,528	0.15	14
	102	10,294	1.03	990	0.10	9,304	0.93	90
	103	6,027	0.60	3,747	0.37	2,280	0.23	38
	104	9,166	0.92	2,065	0.21	7,101	0.71	77
	105	21,973	2.20	20,421	2.04	1,552	0.16	7
	106	8,906	0.89	1,045	0.10	7,861	0.79	88
	107	2,896	0.29	2,081	0.21	815	0.08	28
		70,293	7.03	39,852	3.98	30,441	3.05	43

Areas contributing to Pond	101-104,106	45,425	4.54	17,351	1.73	28,074.00	2.81	62

Ground Slope Calculations

Scenario	Catchmt ID	Upper Elev (m)	Lower Elev (m)	Flow Length (m)	Ground Slope* (m/m)
Pre	1	289.12	288.76	32.76	0.011
		284.95	282.40	35.96	0.071
		298.01	289.01	109.16	0.082
				Average=	**0.055**
Post	101	-	-	-	0.005
		-	-	-	0.020
		-	-	-	0.020
				Average=	**0.015**
Post	102	-	-	-	0.005
		-	-	-	0.020
		-	-	-	0.020
				Average=	**0.015**
Post	103	290.00	288.93	18.99	0.056
		284.95	282.40	35.96	0.071
		284.03	283.83	16.26	0.012
				Average=	**0.047**
Post	104	-	-	-	0.020
		-	-	-	0.020
		-	-	-	0.020
				Average=	**0.020**
Post	105	298.01	289.01	109.16	0.082
		290.56	290.14	24.68	0.017
		284.53	282.24	20.91	0.110
				Average=	**0.070**
Post	106	-	-	-	0.005
		-	-	-	0.020
		-	-	-	0.020
				Average=	**0.015**
Post	107	-	-	-	0.080
		-	-	-	0.040
		-	-	-	0.020
				Average=	**0.047**

Manning's Pervious n

Table of Overland Flow Manning's n Values

Surface Description	n
Smooth surfaces (concrete, asphalt, gravel, bare soil)	0.011
Fallow fields or loose soil surface (no residue)	0.050
Cultivated soil (residue cover < 20%)	0.060
Cultivated soil (residue cover > 20%)	0.170
Short prarie grass and lawns	0.150
Dense grases	0.240
Bermuda grass	0.410
Range (natural)	0.130
Woods or forest with light underbrush	0.400
Woods or forest with dense underbrush	0.800

Sources: USDA 210-VI-TR-55, Second Edition, June 1986
SWMM Hydrology: Runoff and Service Modules pg. 153 (James et al, October 2002)

Manning's n Values

Woods	Lawn	Smooth
0.400	0.150	0.011

		Landuse Areas (ha)				Weighted n			
Scenario	Catchmt ID	Woods	Lawn	Smooth	Total Area	Woods	Lawn	Smooth	Total[2] n
Pre	1	3.41	1.65	1.96	7.02	0.194	0.035	0.003	0.233
Post	101	0.69	0.26	0.15	1.10	0.251	0.035	0.002	0.288
Post	102	0.03	0.07	0.93	1.03	0.012	0.010	0.010	0.032
Post	103	0.31	0.06	0.23	0.60	0.207	0.015	0.004	0.226
Post	104	0.00	0.21	0.71	0.92	0.000	0.034	0.008	0.043
Post	105	1.22	0.82	0.16	2.20	0.222	0.056	0.001	0.279
Post	106	0.00	0.10	0.79	0.89	0.000	0.017	0.010	0.027
Post	107	0.06	0.15	0.08	0.29	0.083	0.078	0.003	0.163

[2] A default value of 0.150 was used for catchments without any pervious area since SWMM requires an input value.

Infiltration Parameters

Typical Inifiltration Parameters (Green-Ampt Method)

HSG	S_u (mm)	K_s (mm/hr)	IMD (mm/mm)
A	100	25	0.34
AB*	200	19	0.33
B	300	13	0.32
BC*	275	9	0.29
C	250	5	0.26
CD*	215	4	0.24
D	180	3	0.21

HSG=Soil Conservation Service Hydrologic Soils Group classification

*values interpolated from bounding values

Source: D.C. 1.13 pg. 117 (MTO Drainage Management Manual, 1997)

	Infil Params	Infil Params
	HSG=C	HSG=B
S_u	250	300
K_s	5	13
IMD	0.26	0.32

		Soil Areas			Area Ratios		Weighted Infiltration Parameters		
Scenario	Catchmt ID	Bedrock, Till, Peat (HSG=C)	Sandy Silt (HSG=B)	Total Area	Bedrock (Till, Peat) (HSG=C)	Sandy Silt (HSG=B)	S_u	K_s	IMD
Pre	1	1.96	5.07	7.03	0.28	0.72	286	11	0.30
Post	101	0.35	0.75	1.10	0.32	0.68	284	10	0.30
Post	102	1.03	0.00	1.03	1.00	0.00	250	5	0.26
Post	103	0.18	0.42	0.60	0.30	0.70	285	11	0.30
Post	104	0.09	0.83	0.92	0.10	0.90	295	12	0.31
Post	105	0.13	2.07	2.20	0.06	0.94	297	13	0.32
Post	106	0.12	0.77	0.89	0.13	0.87	293	12	0.31
Post	107	0.06	0.23	0.29	0.21	0.79	290	11	0.31

Runoff Data for PCSWMM 2002

SUBCATCHMENT DATA - Green and Ampt Infiltration

Scenario	Line ID	Hyetgrph Number	Subcatch ID	Inlet ID	Subcatch Width (m)	Subcatch Area (ha)	% Imperv	Ground Slope (m/m)	Imperv Mannings	Perv Mannings	Imperv Depress Storage (mm)	Perv Depress Storage* (mm)	Ave Capillary Suction (mm)	Saturated Hydraulic Conduct (mm/hr)	Initial Moisture Deficit*	Max Infil Volume
		JK	NAMEW	NGTO	WW(1)	WAREA	WW(3)	WSLOPE	WW(5)	WW(6)	WSTORE1	WSTORE2	SUCT	HYDCON	SMDMAX	RMAXINF
Pre	H1 *	1	1	1	391	7.03	28	0.055	0.011	0.233	1.5	5.0	286	11	0.10	
Post	H1	1	101	101	70	1.10	14	0.015	0.011	0.288	1.5	5.0	284	10	0.10	
Post	H1	1	102	102	125	1.03	90	0.015	0.011	0.032	1.5	5.0	250	5	0.10	
Post	H1	1	103	103	130	0.60	38	0.047	0.011	0.226	1.5	5.0	285	11	0.10	
Post	H1	1	104	104	185	0.92	77	0.020	0.011	0.043	1.5	5.0	295	12	0.10	
Post	H1	1	105	105	290	2.20	7	0.070	0.011	0.279	1.5	5.0	297	13	0.10	
Post	H1	1	106	106	172	0.89	88	0.015	0.011	0.027	1.5	5.0	293	12	0.10	
Post	H1	1	107	107	65	0.29	28	0.047	0.011	0.163	1.5	5.0	290	11	0.10	

* Typical IMD values range from 0.03 to 0.30. A lower IMD value relates to a higher antecedent moisture condition. A conservative IMD value of 0.10 was used for design purposes (see Bedient-Huber pg. 57)

APPENDIX C
Culvert and Ditch Design Report

Culvert Calculator Report
CULVERT 1

Solve For: Discharge

Culvert Summary

Allowable HW Elevation	285.15 m	Headwater Depth/Height	1.98
Computed Headwater Elev:	285.15 m	Discharge	1.8152 m^3/s
Inlet Control HW Elev.	285.15 m	Tailwater Elevation	280.80 m
Outlet Control HW Elev.	284.91 m	Control Type	Inlet Control

Grades

Upstream Invert	283.94 m	Downstream Invert	283.58 m
Length	20.20 m	Constructed Slope	0.017822 m/m

Hydraulic Profile

Profile	S2	Depth, Downstream	0.42 m
Slope Type	Steep	Normal Depth	0.38 m
Flow Regime	Supercritical	Critical Depth	0.61 m
Velocity Downstream	3.54 m/s	Critical Slope	0.004924 m/m

Section

Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	1.22 m
Section Size	1220 x 610 mm	Rise	0.61 m
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	284.91 m	Upstream Velocity Head	0.30 m
Ke	0.20	Entrance Loss	0.06 m

Inlet Control Properties

Inlet Control HW Elev.	285.15 m	Flow Control	N/A
Inlet Type	90° headwall w 3/4 inch chamfers	Area Full	0.7 m^2
K	0.51500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	1
C	0.03750	Equation Form	2
Y	0.79000		

Culvert Calculator Report
Culvert 2

Solve For: Discharge

Culvert Summary					
Allowable HW Elevation	286.40	m	Headwater Depth/Height	1.68	
Computed Headwater Elev:	286.40	m	Discharge	0.3132	m³/s
Inlet Control HW Elev.	286.40	m	Tailwater Elevation	285.00	m
Outlet Control HW Elev.	286.36	m	Control Type	Inlet Control	

Grades					
Upstream Invert	285.63	m	Downstream Invert	285.00	m
Length	12.50	m	Constructed Slope	0.050400	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.29	m
Slope Type	Steep		Normal Depth	0.29	m
Flow Regime	Supercritical		Critical Depth	0.39	m
Velocity Downstream	2.87	m/s	Critical Slope	0.024770	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.020	
Section Material	Corrugated HDPE 18-24 inch (Corrugated Interior)		Span	0.46	m
Section Size	450 mm		Rise	0.46	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	286.36	m	Upstream Velocity Head	0.23	m
Ke	0.50		Entrance Loss	0.11	m

Inlet Control Properties					
Inlet Control HW Elev.	286.40	m	Flow Control	Submerged	
Inlet Type	Square edge w/headwall		Area Full	0.2	m²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Calculator Report
CULVERT 3

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	287.24 m	Headwater Depth/Height	2.43
Computed Headwater Eleva	287.24 m	Discharge	0.4119 m^3/s
Inlet Control HW Elev.	287.24 m	Tailwater Elevation	286.00 m
Outlet Control HW Elev.	287.07 m	Control Type	Inlet Control

Grades			
Upstream Invert	286.13 m	Downstream Invert	285.12 m
Length	12.60 m	Constructed Slope	0.080159 m/m

Hydraulic Profile			
Profile	CompositePressureProfileS1S2	Depth, Downstream	0.30 m
Slope Type	N/A	Normal Depth	0.30 m
Flow Regime	N/A	Critical Depth	0.43 m
Velocity Downstream	3.61 m/s	Critical Slope	0.039265 m/m

Section			
Section Shape	Circular	Mannings Coefficient	0.020
Section Material	Corrugated HDPE (Corrugated Interior)	Span	0.46 m
Section Size	450 mm	Rise	0.46 m
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	287.07 m	Upstream Velocity Head	0.34 m
Ke	0.50	Entrance Loss	0.17 m

Inlet Control Properties			
Inlet Control HW Elev.	287.24 m	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	0.2 m^2
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Calculator Report
CULVERT 4

Solve For: Discharge

Culvert Summary					
Allowable HW Elevation	286.56	m	Headwater Depth/Height	3.15	
Computed Headwater Elev:	286.56	m	Discharge	0.4733	m^3/s
Inlet Control HW Elev.	286.51	m	Tailwater Elevation	285.30	m
Outlet Control HW Elev.	286.56	m	Control Type	Outlet Control	

Grades					
Upstream Invert	285.12	m	Downstream Invert	285.00	m
Length	22.00	m	Constructed Slope	0.005455	m/m

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	0.44	m
Slope Type	Mild		Normal Depth	N/A	m
Flow Regime	Subcritical		Critical Depth	0.44	m
Velocity Downstream	2.93	m/s	Critical Slope	0.018757	m/m

Section				
Section Shape	Circular	Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)	Span	0.46	m
Section Size	450 mm	Rise	0.46	m
Number Sections	1			

Outlet Control Properties					
Outlet Control HW Elev.	286.56	m	Upstream Velocity Head	0.42	m
Ke	0.50		Entrance Loss	0.21	m

Inlet Control Properties					
Inlet Control HW Elev.	286.51	m	Flow Control	Submerged	
Inlet Type	Square edge w/headwall		Area Full	0.2	m^2
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Calculator Report
CULVERT 5

Solve For: Discharge

Culvert Summary					
Allowable HW Elevation	283.66	m	Headwater Depth/Height	2.48	
Computed Headwater Elev:	283.66	m	Discharge	2.0089	m^3/s
Inlet Control HW Elev.	283.66	m	Tailwater Elevation	281.70	m
Outlet Control HW Elev.	283.39	m	Control Type	Inlet Control	

Grades					
Upstream Invert	282.15	m	Downstream Invert	281.95	m
Length	16.00	m	Constructed Slope	0.012500	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.51	m
Slope Type	Steep		Normal Depth	0.47	m
Flow Regime	Supercritical		Critical Depth	0.61	m
Velocity Downstream	3.24	m/s	Critical Slope	0.010336	m/m

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	1.22	m
Section Size	1220 x 610 mm		Rise	0.61	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	283.39	m	Upstream Velocity Head	0.37	m
Ke	0.70		Entrance Loss	0.26	m

Inlet Control Properties					
Inlet Control HW Elev.	283.66	m	Flow Control	Submerged	
Inlet Type	0° wingwall flares		Area Full	0.7	m^2
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

Culvert Calculator Report
EXISTING CULVERT 6

Solve For: Discharge

Culvert Summary					
Allowable HW Elevation	277.46	m	Headwater Depth/Height	1.50	
Computed Headwater Eleva	277.46	m	Discharge	1.0044	m^3/s
Inlet Control HW Elev.	277.46	m	Tailwater Elevation	276.00	m
Outlet Control HW Elev.	277.43	m	Control Type	Inlet Control	

Grades					
Upstream Invert	276.32	m	Downstream Invert	276.20	m
Length	11.90	m	Constructed Slope	0.010252	m/m

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.54	m
Slope Type	Steep		Normal Depth	0.51	m
Flow Regime	Supercritical		Critical Depth	0.62	m
Velocity Downstream	2.91	m/s	Critical Slope	0.006532	m/m

Section					
Section Shape	Circular		Mannings Coefficient	0.012	
Section Material	Corrugated HDPE (Smooth Interior)		Span	0.76	m
Section Size	750 mm		Rise	0.76	m
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	277.43	m	Upstream Velocity Head	0.33	m
Ke	0.50		Entrance Loss	0.16	m

Inlet Control Properties					
Inlet Control HW Elev.	277.46	m	Flow Control	Submerged	
Inlet Type	Square edge w/headwall		Area Full	0.5	m^2
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Culvert Calculator Report
EXISTING CULVERT 7

Solve For: Discharge

Culvert Summary

Allowable HW Elevation	278.20 m	Headwater Depth/Height	1.41
Computed Headwater Eleva	278.20 m	Discharge	0.5508 m^3/s
Inlet Control HW Elev.	278.20 m	Tailwater Elevation	276.00 m
Outlet Control HW Elev.	278.20 m	Control Type	Entrance Control

Grades

Upstream Invert	277.34 m	Downstream Invert	276.28 m
Length	22.20 m	Constructed Slope	0.047748 m/m

Hydraulic Profile

Profile	S2	Depth, Downstream	0.27 m
Slope Type	Steep	Normal Depth	0.25 m
Flow Regime	Supercritical	Critical Depth	0.48 m
Velocity Downstream	4.35 m/s	Critical Slope	0.006712 m/m

Section

Section Shape	Circular	Mannings Coefficient	0.012
Section Material	HDPE (Smooth Interior)	Span	0.61 m
Section Size	600 mm	Rise	0.61 m
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	278.20 m	Upstream Velocity Head	0.25 m
Ke	0.50	Entrance Loss	0.13 m

Inlet Control Properties

Inlet Control HW Elev.	278.20 m	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	0.3 m^2
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Culvert Calculator Report
EXISTING CULVERT 8

Solve For: Discharge

Culvert Summary

Allowable HW Elevation	279.84 m	Headwater Depth/Height	1.94
Computed Headwater Elev.	279.84 m	Discharge	0.7117 m^3/s
Inlet Control HW Elev.	279.84 m	Tailwater Elevation	278.20 m
Outlet Control HW Elev.	279.72 m	Control Type	Inlet Control

Grades

Upstream Invert	278.66 m	Downstream Invert	278.44 m
Length	14.00 m	Constructed Slope	0.015714 m/m

Hydraulic Profile

Profile	S2	Depth, Downstream	0.45 m
Slope Type	Steep	Normal Depth	0.42 m
Flow Regime	Supercritical	Critical Depth	0.54 m
Velocity Downstream	3.10 m/s	Critical Slope	0.009432 m/m

Section

Section Shape	Circular	Mannings Coefficient	0.012
Section Material	Corrugated HDPE (Smooth Interior)	Span	0.61 m
Section Size	600 mm	Rise	0.61 m
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	279.72 m	Upstream Velocity Head	0.35 m
Ke	0.50	Entrance Loss	0.17 m

Inlet Control Properties

Inlet Control HW Elev.	279.84 m	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	0.3 m^2
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

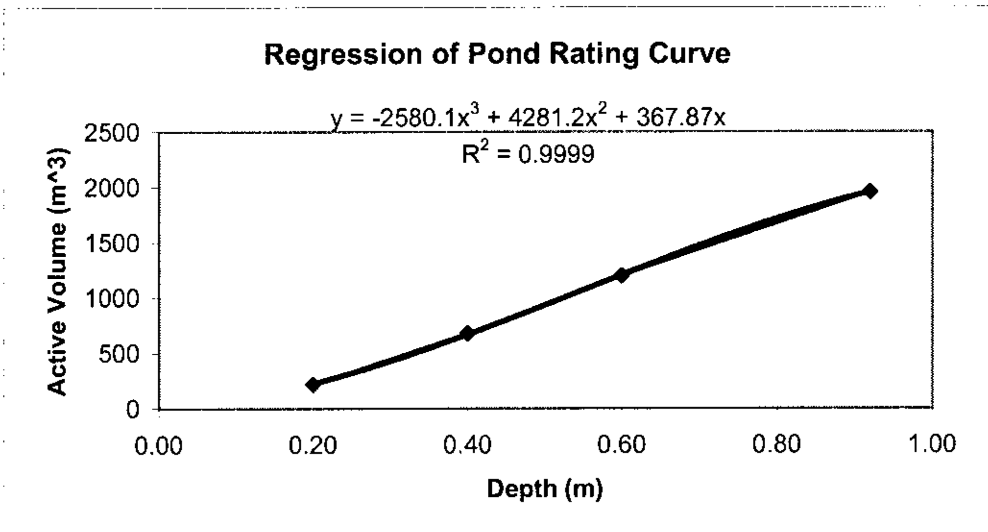
APPENDIX D
Channel Erosion Protection Requirements

APPENDIX E
SMW Pond Rating Curve and Water Quality Storage Calculations

Pond Rating Curves

Pond (w/ forebay) - (Wet Pond) - 3:1 & 5:1

	Elev (m)	Depth (m)	Area (m^2)	Inc Vol (m^3)	Total Vol (m^3)	Active Depth (m)	Active Vol (m^3)
Permanent Pool	278.320	0.00	254	0	0		
	278.750	0.43	386	138	138		
	279.250	0.93	549	234	371		
	279.850	**1.53**	**1011**	**468**	**839**	**0.00**	**0**
Active Storage	280.050	1.73	1151	216	1056	0.20	216
	280.250	1.93	1298	462	1517	0.40	678
	280.450	2.13	1452	521	2038	0.60	1199
	280.770	2.45	1606	755	2793	0.92	1954



SWMP Manual Water Quality Sizing Criteria
(Regression of Table 3.2)

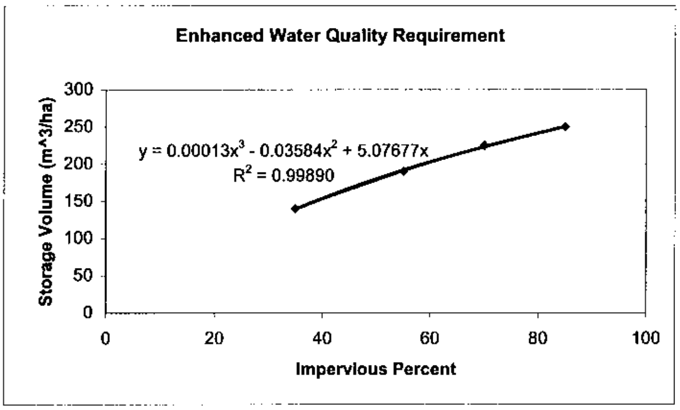
80% Removal Efficiency
Storage Volume for Impervious Level Equation
$y = A*x^3 + B*x^2 + C*x$

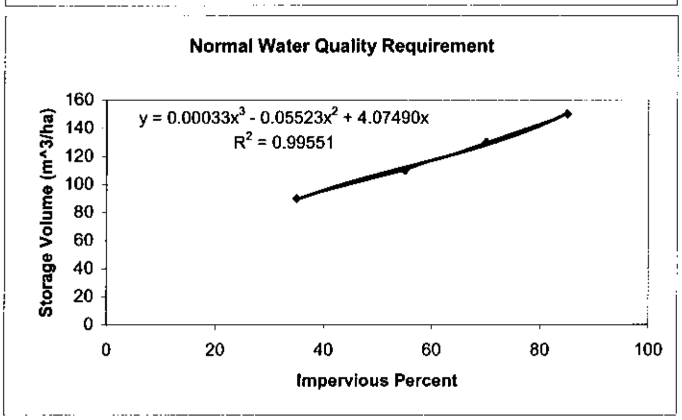
	80%	70%	60%
A	0.00013	0.00033	0.00017
B	-0.03584	-0.05523	-0.03188
C	5.07677	4.0749	2.61954

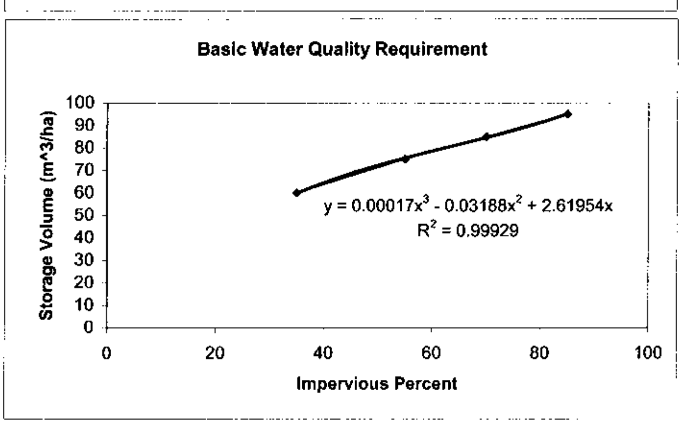
	% imp (x)	storage (m^3/ha) (y) 80%	70%	60%
Pond 1	80	243	141	93

Storage Volume for Impervious Level

Protection Level	TSS Removal	SWMP Type	Impervious Percent 35	55	70	85
Enhanced	80%	Wet Pond	140	190	225	250
Normal	70%	Wet Pond	90	110	130	150
Basic	60%	Wet Pond	60	75	85	95







Pond Water Quality Requirments

Pond 1-Wet Pond

total area:	**4.54**	
impervious area:	**2.81**	
	62	% Impervious
total requirement:	**207**	m^3/ha
ext det requirement:	**40**	m^3/ha
perm pool requirement:	**167**	m^3/ha
ext det requirement:	**182**	m^3
perm pool requirement:	**758**	m^3
total requirement:	**940**	m^3

APPENDIX F
Forebay Design and Calculations

Forebay Design (Pond 1)

Forebay Settling Length		
R=	2	Length to width ratio, typically 2
Q_p=	0.026 m^3/s	Peak flow rate at outlet from 25-mm event
Vs=	0.0003 m/s	Setling velocity , typically 0.0003
Distance=	13 m	Forebay Length
Dispersion Length		
Q=	0.874 m^3/s	Peak flow rate at intlet from 5-yr event
d=	1.53 m	Depth of permanent pool
V_f=	0.5 m/s	desired velocity, typically 0.5
Distance=	9 m	Forebay Length
Width=	1	Minimum Forebay botton Width
Check for 25-mm Event Flow Velocity		
d=	0.25 m	25-mm event flow depth
S=	5 :1	Pond side slope
BW=	15.67 m	Bottom width of flow area
A=	4.2 m^2	Average cross-sectional flow area
Q=	0.382 m^3/s	Peak flow rate at intlet from 25-mm event
V=	0.09 m/s	Velocity must be less than 0.15 m/s

APPENDIX G
Extended Detention Calculations and Drawdown Time

Extended Detention Calculations
SWM Pond 1

Orifice 1-1	
Inv Elev (m):	279.85
Diam (mm):	200

pond storage-depth equation

$y = A*x^3 + B*x^2 + C*x$

A	B	C
-2580.1	4281.2	367.87

Water Quality Storage Requirement: **182** m^3 (Based on 40 m^3/ha)

Erosion Control Storage Requirement: **382** m^3 (Based on runoff volume from 25-mm storm)

Ext. Det. Storage Requirement: **382** m^3

total drawdown time: 29 hrs

maximum outflow rate: 0.026 m^3/s

WS Elev (m)	Storage Depth (m)	Total Flowrate (m^3/s)	Storage (m^3)	Section Volume (m^3)	Section Drain Time (hr)	Cum Drain Time (hr)
280.15	0.30	0.0260	426			
280.10	0.25	0.0210	319	107	1.3	1
280.05	0.20	0.0140	224	95	1.5	3
280.00	0.15	0.0070	143	81	2.2	5
279.95	0.10	0.0020	77	66	4.1	9
279.90	0.05	0.0010	29	48	8.9	18
279.85	0.00	0.0005	0	29	10.7	29

APPENDIX H
SWM Pond Target Flow Calculations

Pond Target Flows

Pond Outlet to Drainage Course

Storm Event	Pre-Dev Flow Node 1 (m^3/s)	Catchment 107 (m3/s)	Pond Target Flows (m3/s)	Pond Target Storage (m3/s)
Ext. Det			0.026	426
2-yr	0.494	0.011	0.483	441
5-yr	0.752	0.032	0.720	482
25-yr	1.253	0.053	1.200	536
100-yr	1.704	0.116	1.588	572

APPENDIX I
Active Storage Orifice Design and Calculations

Stage-Storage-Discharge Operation (Pond 1)

pond storage-depth equation

$y = A*x^3 + B*x^2 + C*x$

A	B	C
-2580.1	4281.2	367.87

Orifice 1-1		Orifice 1-2		Orifice 1-3	
Inv Elev (m):	279.85	Inv Elev (m):	280.30	Inv Elev (m):	280.15
Diam (mm):	200	Diam (mm):	900	Diam (mm):	900

WS Elev (m)	Storage Depth (m)	Storage* (m^3)	CULVERT 1 HEAD (m)	CULVERT 1 Outflow (m^3/s)	CULVERT 2 HEAD (m)	CULVERT 2 Outflow (m^3/s)	CULVERT 3 HEAD (m)	CULVERT 3 Outflow (m^3/s)	Total Outflow (m^3/s)	Design Storm*
279.850	0.00	0	0.00	0.000	0.00	0.000	0.00	0.000	0.000	
279.900	0.050	29	0.05	0.000	0.00	0.000	0.00	0.000	0.000	
279.950	0.10	77	0.10	0.002	0.00	0.000	0.00	0.000	0.002	
280.000	0.15	143	0.15	0.007	0.00	0.000	0.00	0.000	0.007	
280.050	0.20	224	0.20	0.014	0.00	0.000	0.00	0.000	0.014	
280.100	0.25	319	0.25	0.021	0.00	0.000	0.00	0.000	0.021	
280.150	**0.30**	**426**	**0.30**	**0.026**	**0.00**	**0.000**	**0.00**	**0.000**	**0.026**	**Ext. Det.**
280.200	**0.35**	**543**	**0.35**	**0.030**	**0.00**	**0.000**	**0.05**	**0.004**	**0.034**	**2-25-yr**
280.250	**0.40**	**667**	**0.40**	**0.033**	**0.00**	**0.000**	**0.10**	**0.014**	**0.047**	**100-yr**
280.300	0.45	797	0.45	0.036	0.00	0.000	0.15	0.031	0.067	
280.350	0.50	932	0.50	0.039	0.05	0.004	0.20	0.055	0.098	
280.400	0.55	1068	0.55	0.042	0.10	0.014	0.25	0.085	0.141	
280.450	0.60	1205	0.60	0.045	0.15	0.031	0.30	0.121	0.197	
280.500	0.65	1339	0.65	0.048	0.20	0.055	0.35	0.162	0.265	
280.550	0.70	1470	0.70	0.050	0.25	0.085	0.40	0.208	0.343	
280.600	0.75	1596	0.75	0.052	0.30	0.121	0.45	0.259	0.432	
280.650	0.80	1713	0.80	0.055	0.35	0.162	0.50	0.315	0.532	
280.700	0.85	1821	0.85	0.057	0.40	0.208	0.55	0.375	0.641	
280.750	0.90	1918	0.90	0.059	0.45	0.259	0.60	0.439	0.758	
280.770	**0.92**	**1953**	**0.92**	**0.060**	**0.47**	**0.281**	**0.62**	**0.466**	**0.807**	

Notes:

1. The above table is based on regular increments in the depth of storage. The design storm column is only included to give a general indication of the approximate water surface elevations, outflow, and storage volume associated with each design storm frequency. The bolded outflow and storage values indicate locations of hydraulic change for the storage area (e.g. orifice and weir invert locations) as well as representative rating curve locations, and were used for the storage area rating curve in the PCSWMM 2002 computer model. Refer to Appendix B for actual design storm outflow and storage values.

2. Orifice coefficients obtained from *Dally, J.W., W.F. Riley, and K.G. McConnell. 1993. Instrumentation for Engineering Measurements. John Wiley and Sons, Inc. 2ed.*

3. Weir coefficient based upon Design Chart 2.43 Coefficient of Discharge for Rectangular Broad Crested Weir (MTO DMM 1997)

APPENDIX J
Emergency Overflow Outlet Design and Calculations

Weir Report

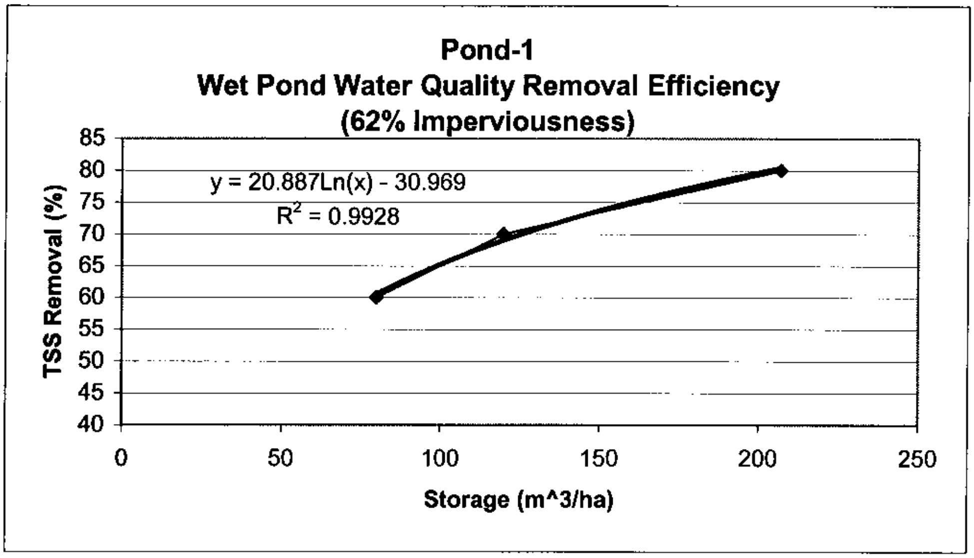
Label	Discharge (m^3/s)	Headwater Elevation (m)	Crest Elevation (m)	Tailwater Elevation (m)	Crest Surface Type	Crest Breadth (m)	Discharge Coefficient	Crest Length (m)	Headwater Height Above Crest (m)	Tailwater Height Above Crest (m)	Equal Side Slopes (H : V)	Submergence Factor	Adjusted Discharge Coefficient (SI)	Flow Area (m^2)	Velocity (m/s)	Wetted Perimeter (m)	Top Width (m)
Pond Emergency Overflow	1.8050	280.77	280.35	275.78	Gravel	23.00	1.60	4.14	0.42	-4.57		1.00	1.60	1.7	1.04	4.98	4.14

APPENDIX K
Sediment Removal Frequency Calculations

Pond-1 Sediment Cleanout Frequency-Ultimate Conditions

Pond-1 Removal Efficiency Summary (62% Impervious)
(Table 3.2, pg. 3-10 SWMP Manual)

Removal Efficiency (%)	Storage Volume (m^3/ha)
60	80
70	120
80	207



Appropriate TSS Removal Efficiency:	80	%
Allowable Reduction in TSS Removal Efficiency:	5	%
Target Maintenance TSS Removal Efficiency:	75	%

Drainage Area:	4.54	ha	
Impervious % Used:	62	%	
Unit Annual Loading:	2.35	m^3/ha/yr	(Table 6.3, pg. 6-13 SWMP Manual)
Annual Loading:	10.7	m^3/yr	

Removal Efficiency Equation
y= A*Ln(x) + B

A	B
24.952	-35.301

Annual Breakdown of Sediment Loading and Removal Efficiency

Year	PP Storage (m^3)	Unit PP Storage (m^3/ha)	Unit Ext Det Storage (m^3/ha)	Total Unit Storage (m^3/ha)	Removal Efficiency (%)	Annual Loading To Pond (m^3)	End of Year PP Storage (m^3)
1	839	185	40	225	100	10.6	828
2	828	182	40	222	100	10.6	818
3	818	180	40	220	99	10.6	807
4	807	178	40	218	99	10.6	797
5	797	175	40	215	99	10.5	786
6	786	173	40	213	98	10.5	776
7	776	171	40	211	98	10.5	765
8	765	169	40	209	98	10.4	755
9	755	166	40	206	98	10.4	744
10	744	164	40	204	97	10.4	734
11	734	162	40	202	97	10.4	723
12	723	159	40	199	97	10.3	713
13	713	157	40	197	97	10.3	703
14	703	155	40	195	96	10.3	693
15	693	153	40	193	96	10.2	682
16	682	150	40	190	96	10.2	672
17	672	148	40	188	95	10.2	662
18	662	146	40	186	95	10.1	652
19	652	144	40	184	95	10.1	642
20	642	141	40	181	94	10.1	632
21	632	139	40	179	94	10.0	622
22	622	137	40	177	94	10.0	612
23	612	135	40	175	94	10.0	602
24	602	132	40	172	93	9.9	592
25	592	130	40	170	93	9.9	582
26	582	128	40	168	93	9.9	572
27	572	126	40	166	92	9.8	562
28	562	124	40	164	92	9.8	552
29	552	122	40	162	92	9.8	542
30	542	119	40	159	91	9.7	533
31	533	117	40	157	91	9.7	523
32	523	115	40	155	91	9.7	513
33	513	113	40	153	90	9.6	504
34	504	111	40	151	90	9.6	494
35	494	109	40	149	90	9.6	485
36	485	107	40	147	89	9.5	475
37	475	105	40	145	89	9.5	466
38	466	103	40	143	88	9.4	456
39	456	100	40	140	88	9.4	447
40	447	98	40	138	88	9.4	437
41	437	96	40	136	87	9.3	428
42	428	94	40	134	87	9.3	419
43	419	92	40	132	87	9.2	410
44	410	90	40	130	86	9.2	400
45	400	88	40	128	86	9.2	391
46	391	86	40	126	85	9.1	382
47	382	84	40	124	85	9.1	373
48	373	82	40	122	85	9.0	364
49	364	80	40	120	84	9.0	355
50	355	78	40	118	84	8.9	346
51	346	76	40	116	83	8.9	337
52	337	74	40	114	83	8.8	328
53	328	72	40	112	83	8.8	319

Annual Breakdown of Sediment Loading and Removal Efficiency

Year	PP Storage (m^3)	Unit PP Storage (m^3/ha)	Unit Ext Det Storage (m^3/ha)	Total Unit Storage (m^3/ha)	Removal Efficiency (%)	Annual Loading To Pond (m^3)	End of Year PP Storage (m^3)
54	319	70	40	110	82	8.8	311
55	311	68	40	108	82	8.7	302
56	302	67	40	107	81	8.7	293
57	293	65	40	105	81	8.6	285
58	285	63	40	103	80	8.6	276
59	276	61	40	101	80	8.5	268
60	268	59	40	99	79	8.5	259
61	259	57	40	97	79	8.4	251
62	251	55	40	95	78	8.4	242
63	242	53	40	93	78	8.3	234
64	234	52	40	92	77	8.3	226
65	226	50	40	90	77	8.2	218
66	218	48	40	88	76	8.2	209
67	209	46	40	86	76	8.1	201
68	201	44	40	84	75	8.0	193
69	193	43	40	83	75	8.0	185
70	185	41	40	81	74	7.9	177

APPENDIX L
Stormwater Management Sign

ALL DIMENSIONS IN MILLIMETRES AND/OR METRES. DRAWING NOT TO SCALE

Stormwater Management Pond Warning Sign

POSTS TO BE STANDARD MTO APPROVED , 80,000 PSI HOT DIPPED, HOT ROLLED, HOT FORMED GALVANIZED PERFORATED U-CHANNEL 3.6m LONG DRIVEN INTO THE GROUND 0.9m DEEP .

SIGNS TO BE 0.081 THICK 5052 - H38 ALUMINUM

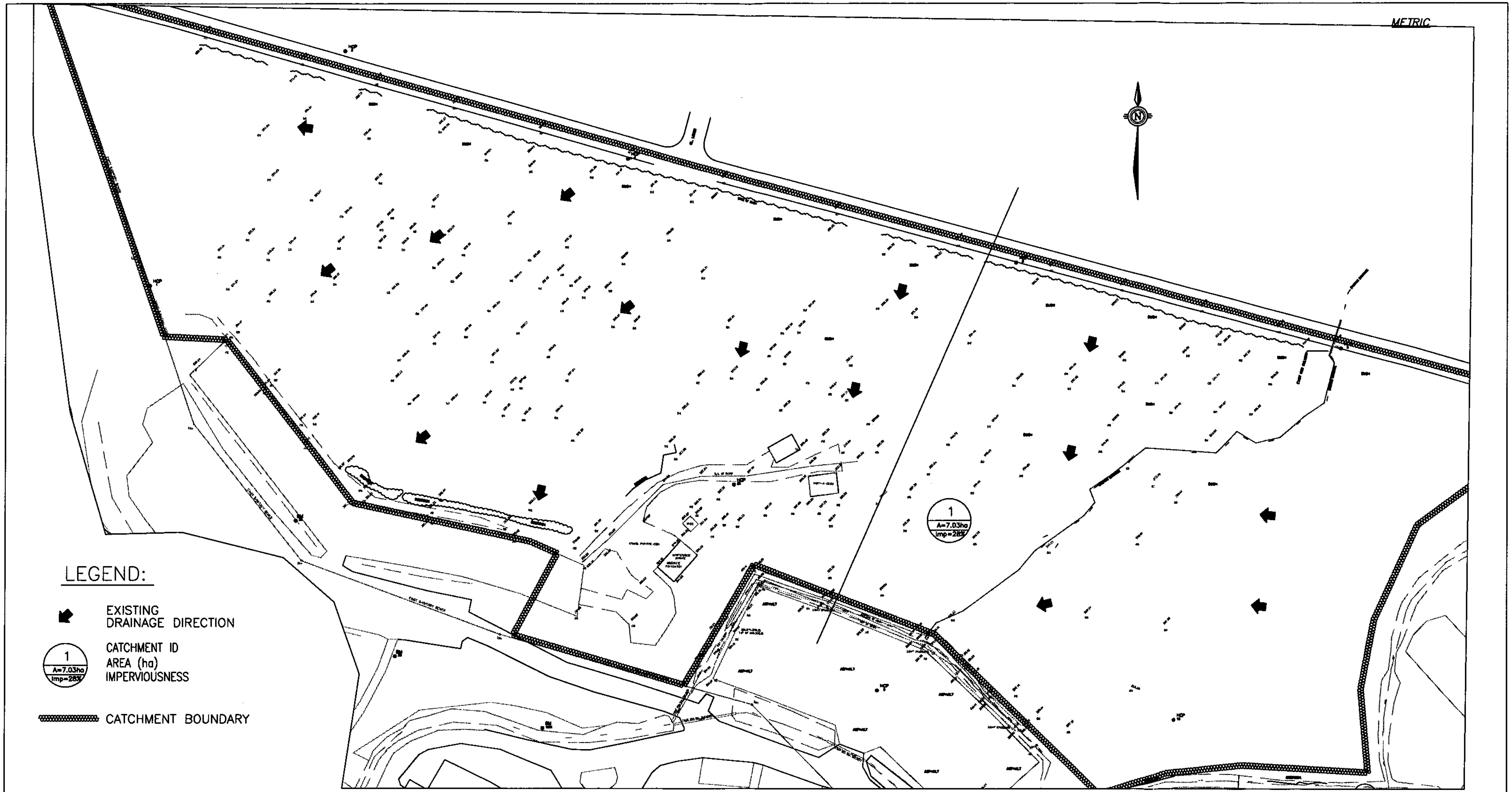
BACKGROUND, TEXT AND GRAPHICS TO BE HIGH INTENSITY TYPE III MATERIAL

COLOR RED: RED INTERDICTORY SYMBOL
COLOR BLACK: FIGURE SYMBOLS, TEXT AND BORDERS

SIGN TO BE CONSPICUOUSLY LOCATED ON ALL SIDES OF THE FACILITY AND/OR WHERE DIRECTED BY THE TOWN.

APPROVED	STORMWATER MANAGEMENT POND WARNING SIGN	DWG No. AS-335
REVISION No. 1		
DATE AUG 25 2003		

APPENDIX M
Drawings



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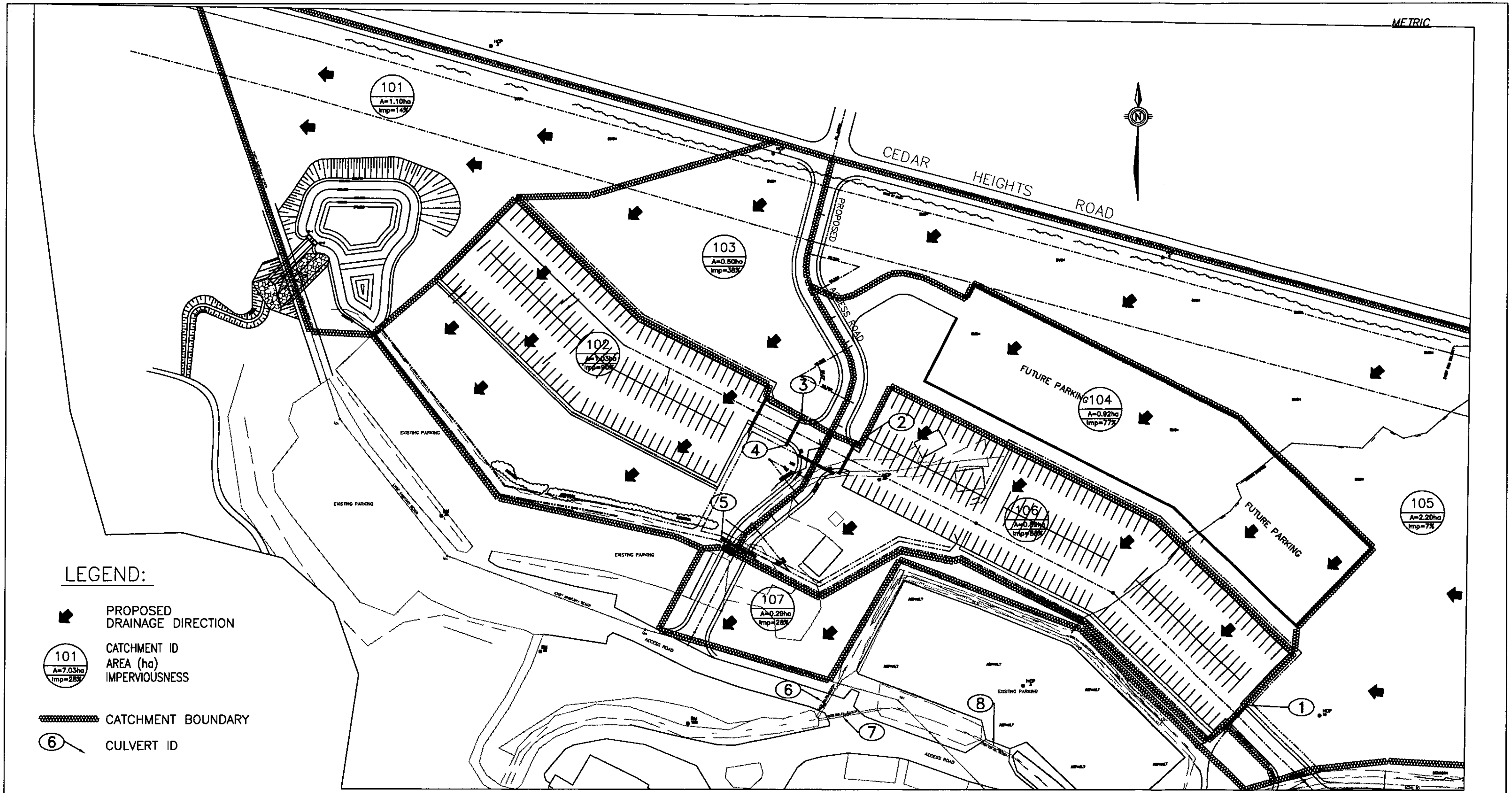
NIPISSING UNIVERSITY, CANADORE COLLEGE
NORTH PARKING LOTS
PRE-DEVELOPMENT CATCHMENT PLAN

DRAWN BY: D.P.N	DATE: JULY 28 2008	
CHECKED BY: D.A.R.	SCALE: 1 : 1,300	
CAD FILE: 4966 SWM DWG		
OFFICE NORTH BAY	PROJECT No 4966	FIGURE No FIG. A.1



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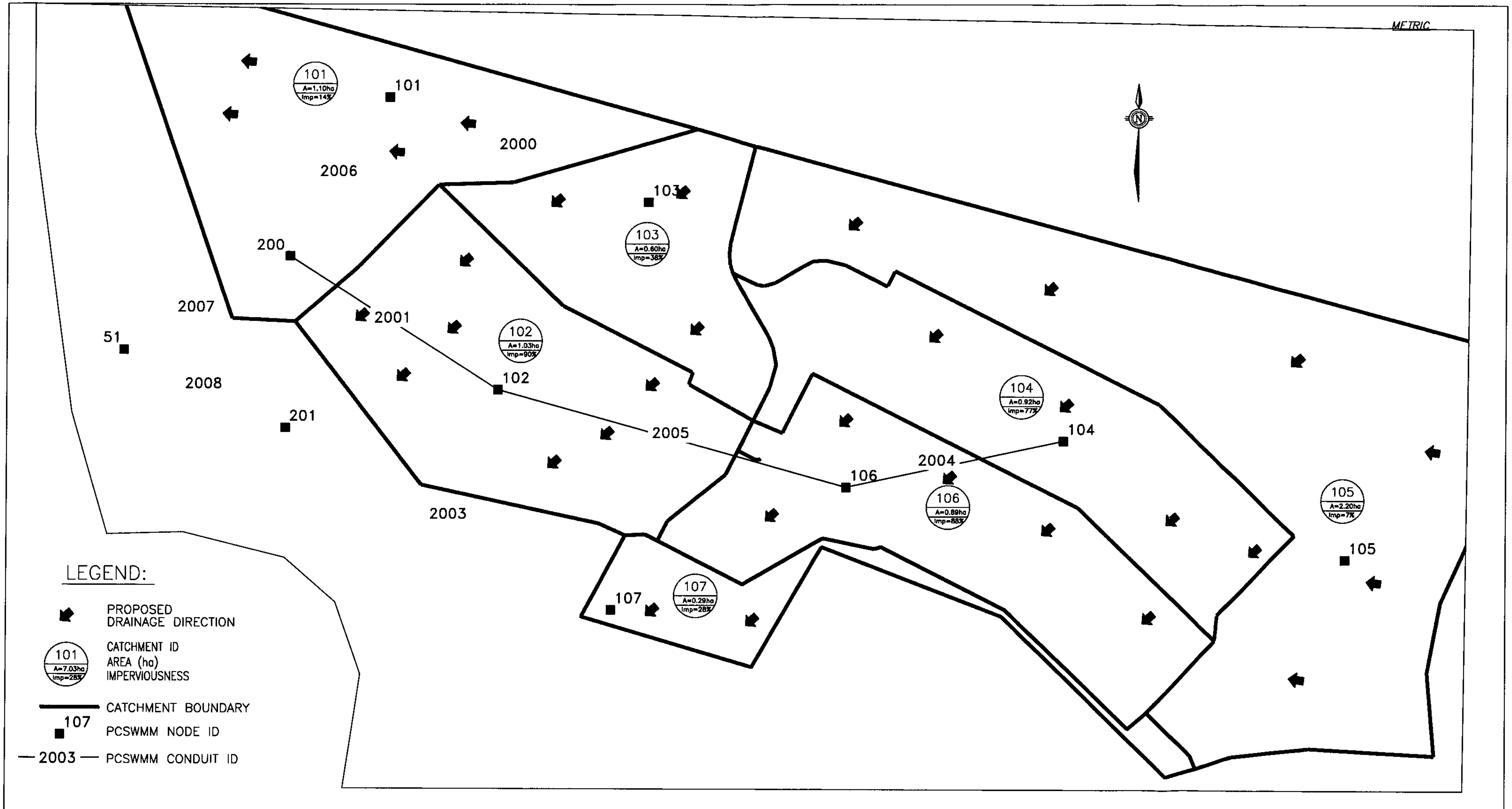
DRAWN BY: D.P.N	DATE: JULY 28 2008
CHECKED BY: D.A.R.	SCALE: 1 : 1,300
CAD FILE: 4966 SWM DWG	
OFFICE: NORTH BAY	PROJECT No: 4966
FIGURE No: FIG. A.2	



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NIPISSING UNIVERSITY, CANADORE COLLEGE
NORTH PARKING LOTS
POST-DEVELOPMENT PCSWMM MODEL SCHEMATIC

DRAWN BY: D.P.N	DATE: JULY 28 2008
CHECKED BY: D.A.R.	SCALE: 1 : 1,300
CAD FILE: 4966 SWM DWG	
OFFICE: NORTH BAY	PROJECT No: 4966
FIGURE No: FIG. B.1	

Trapezoidal Report

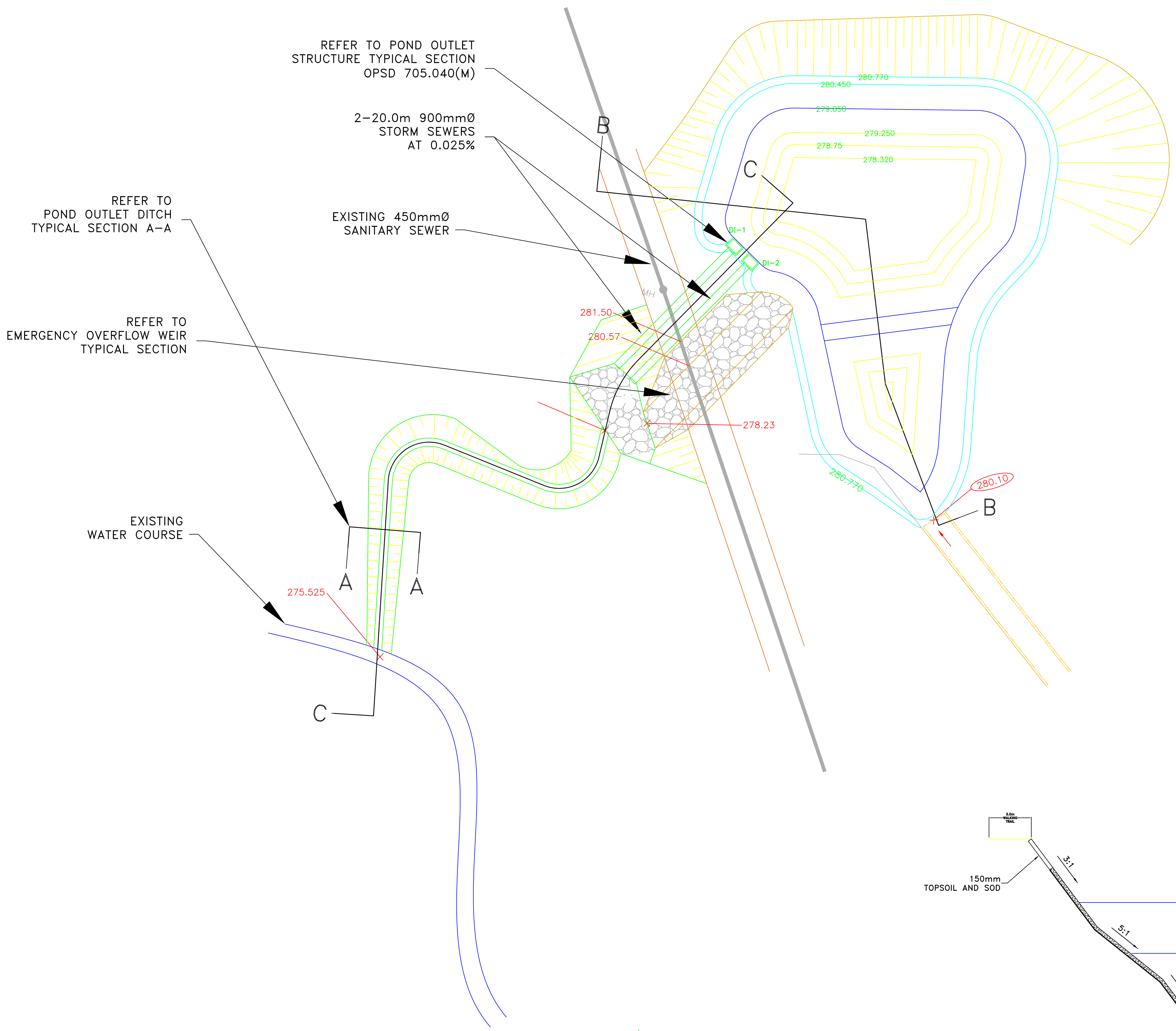
Label	Mannings Coefficient	Slope (m/m)	Depth (m)	Left Side Slope (H : V)	Right Side Slope (H : V)	Bottom Width (m)	Discharge (m^3/s)	Flow Area (m^2)	Wetted Perimeter (m)	Top Width (m)	Critical Depth (m)	Critical Slope (m/m)	Velocity (m/s)	Velocity Head (m)	Specific Energy (m)	Froude Number	Flow Type	Equal Side Slopes (H : V)	Worksheet Type
Cedar Heights Rd Runoff Section D-D	0.040	).030000	0.30	2.00	2.00	2.00	1.3020	0.8	3.35	3.21	0.31	).026307	1.65	0.14	0.44	1.06	Supercritic	0.00	Trapezoid
East Lot North Side Section A-A	0.040	).005000	0.27	2.00	2.00	2.00	0.4200	0.7	3.19	3.06	0.16	).031530	0.63	0.02	0.29	0.43	Subcritical	0.00	Trapezoid
East Lot South Side Section C-C	0.040	).008000	0.46	2.00	2.00	0.75	0.7310	0.8	2.82	2.60	0.34	).028221	0.94	0.05	0.51	0.55	Subcritical	0.00	Trapezoid
Pond Inlet Section B-B	0.040	).015000	0.45	2.00	2.00	2.00	1.8630	1.3	4.00	3.79	0.39	).024964	1.44	0.11	0.55	0.79	Subcritical	0.00	Trapezoid
Pond Outlet Ditch	0.040	).060600	0.45	3.00	3.00	1.00	2.7519	1.1	3.85	3.70	0.56	).023648	2.60	0.35	0.80	1.55	Supercritic	0.00	Trapezoid
West Lot Access Section E-E	0.040	).005000	0.19	2.00	2.00	2.00	0.2370	0.5	2.86	2.77	0.11	).034888	0.52	0.01	0.21	0.41	Subcritical	0.00	Trapezoid
West Lot North Side Section F-F	0.040	).005000	0.19	2.00	2.00	2.00	0.2370	0.5	2.86	2.77	0.11	).034888	0.52	0.01	0.21	0.41	Subcritical	0.00	Trapezoid

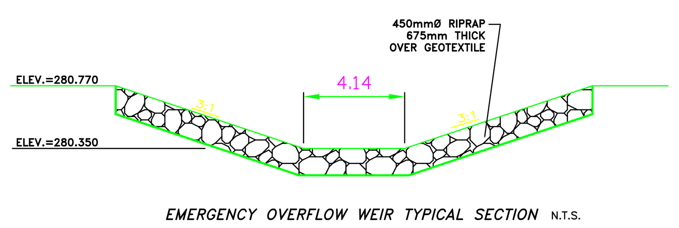
Riprap Channel Lining Design

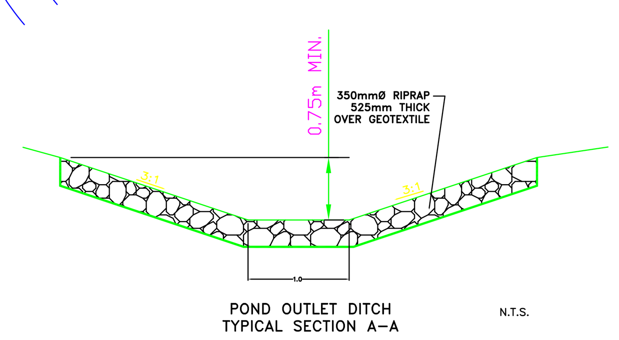
					Tractive Force Due to Flow (Boundary Shear Stress)												Tractive Force of Bed Material (Shear Resistance)									Riprap Design			
Channel	Design Freq	Channel Shape	Design Flow (m^3/s)	Channel Linning	Bottom Width (b_w) (m)	Flow Depth (y) (m)	Flow Area (m^2)	Wetted Perimeter (m)	Hydraulic Radius	Channel Slope (m/m)	Mean Bound Shear Stress (N/m^2)	Bottom Width/ Flow Depth	Trac Force Bed Coeff (K_b)	Trac Force Bank Coeff (K_{bk})	Channel Bed Shear Stress (N/m^2)	Channel Side Shear Stress (N/m^2)	Median Particle Size (D_{50}) (mm)	Channel Side Slope (H:1)	Channel Side Slope (degrees)	Bank Material Angle of Repose (degrees)	Trac Force Side Coeff (K_{cs})	Channel Bottom Shear Resistance (N/m^2)	Channel Side Shear Resistance (N/m^2)	Bed Shear Resistance >Shear Stress?	Side Shear Resistance >Shear Stress?	Max Stone Diam (mm)	Min Stone Diam (mm)	Stone Layer Thickness (mm)	Comment
MTO Design Chart->													**2.11**	**2.12**						**2.13**									See Note 5
Pond Outlet Ditch	100-yr	Trapezoid	0.737	riprap	1.00	0.45	1.10	3.85	0.29	0.045	126	2.2	1.50	1.40	189	177	350	3.0	18.4	42.0	0.88	220	194	O.K.	O.K.	525	300	525	See Note 5
Pond Inlet Section B-B	100-yr	Trapezoid	1.863	riprap	2.00	0.45	1.30	4.00	0.33	0.015	48	4.4	1.35	1.08	65	52	200	3.0	18.4	42.0	0.88	126	111	O.K.	O.K.	300	150	300	See Note 5
Pond Emergency Overflow Weir	100-yr	Trapezoid	1.805	riprap	4.14	0.42	1.70	4.98	0.34	0.040	134	9.9	1.30	1.80	174	241	450	3.0	18.4	42.0	0.88	283	250	O.K.	O.K.	675	400	675	See Note 5
East Lot North side Section A-A	100-yr	Trapezoid	0.420	riprap	2.00	0.27	0.70	3.19	0.22	0.005	11	7.4	1.25	0.95	13	10	veg	3.0	18.4	42.0	0.88	38	33	O.K.	O.K.	N/A	N/A	N/A	See Note 5
East Lot South side Section C-C	100-yr	Trapezoid	0.460	riprap	0.75	0.46	0.80	2.82	0.28	0.008	22	1.6	1.42	1.25	32	28	veg	3.0	18.4	42.0	0.88	38	33	O.K.	O.K.	N/A	N/A	N/A	See Note 5
West Lot North side Section F-F	100-yr	Trapezoid	0.237	riprap	2.00	0.19	0.50	2.86	0.17	0.005	9	10.5	1.20	0.80	10	7	veg	3.0	18.4	42.0	0.88	38	33	O.K.	O.K.	N/A	N/A	N/A	See Note 5
West Lot Access Section E-E	100-yr	Trapezoid	0.237	riprap	2.00	0.19	0.50	2.86	0.17	0.005	9	10.5	1.20	0.80	10	7	veg	3.0	18.4	42.0	0.88	38	33	O.K.	O.K.	N/A	N/A	N/A	See Note 5
Cedar Heights Rd Runoff Section D-D	100-yr	Trapezoid	1.302	riprap	2.00	0.30	0.80	3.35	0.24	0.030	70	6.7	1.30	1.00	91	70	200	3.0	18.4	42.0	0.88	126	111	O.K.	O.K.	300	150	300	See Note 5

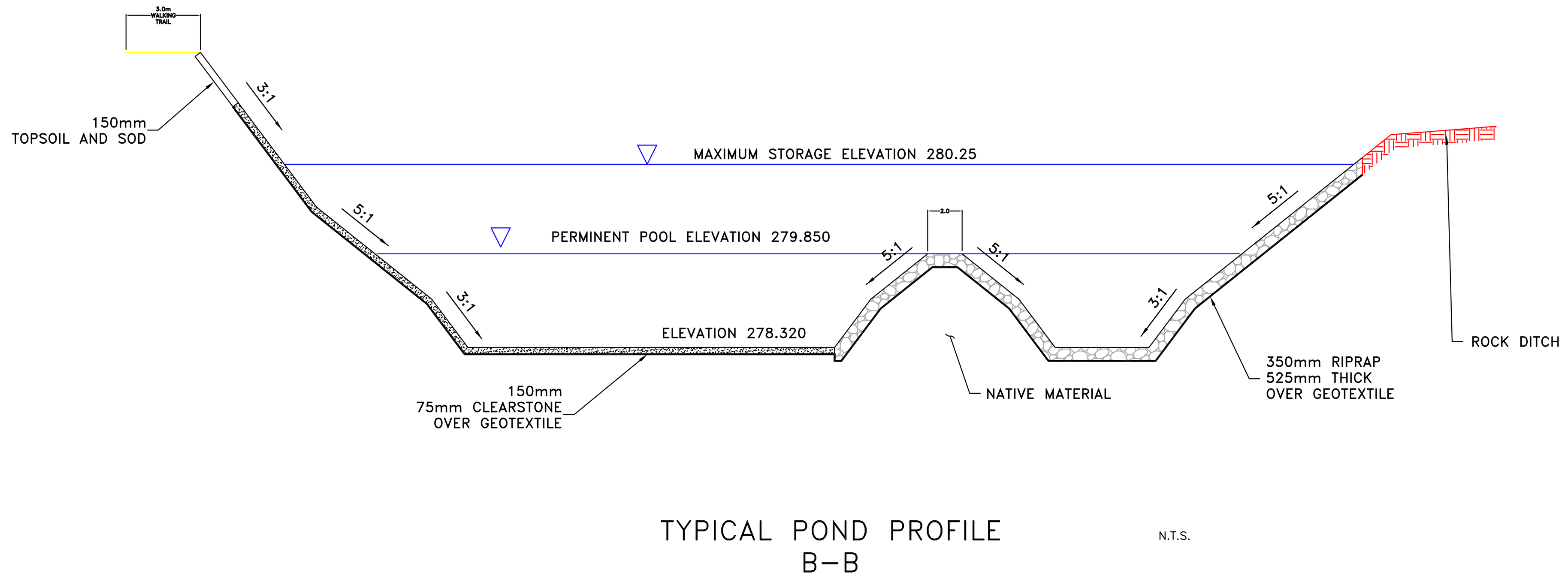
Notes:

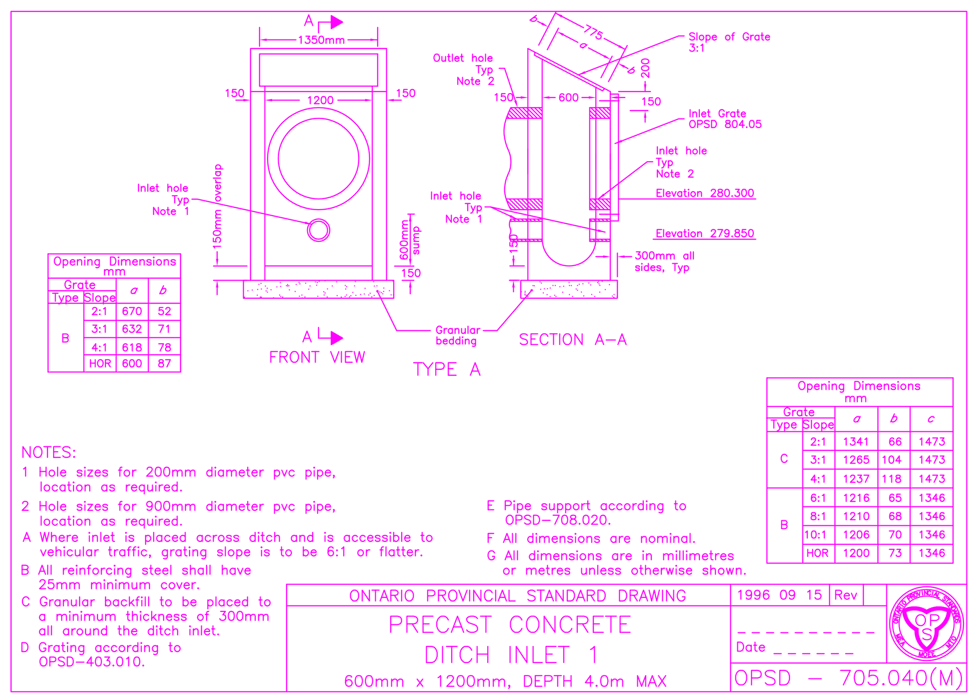
1. Mimimum Stone Size: The greater of 150mm or D_{50} (median stone size) less 50mm.
2. Maximum Stone Size: 1.5*D_{50} (median stone size).
3. Stone Layer Thickness: 1.0*D_{100} (maximum stone size) - (refer to MTO DMM pg. 5.107)
4. Vegetative lining assumed to have a retardence class between Class C & D - (refer to MTO DMM DC 2.16 for permissible shear stress values)
5. Riprap/ Vegetation not required when rock shatter present.

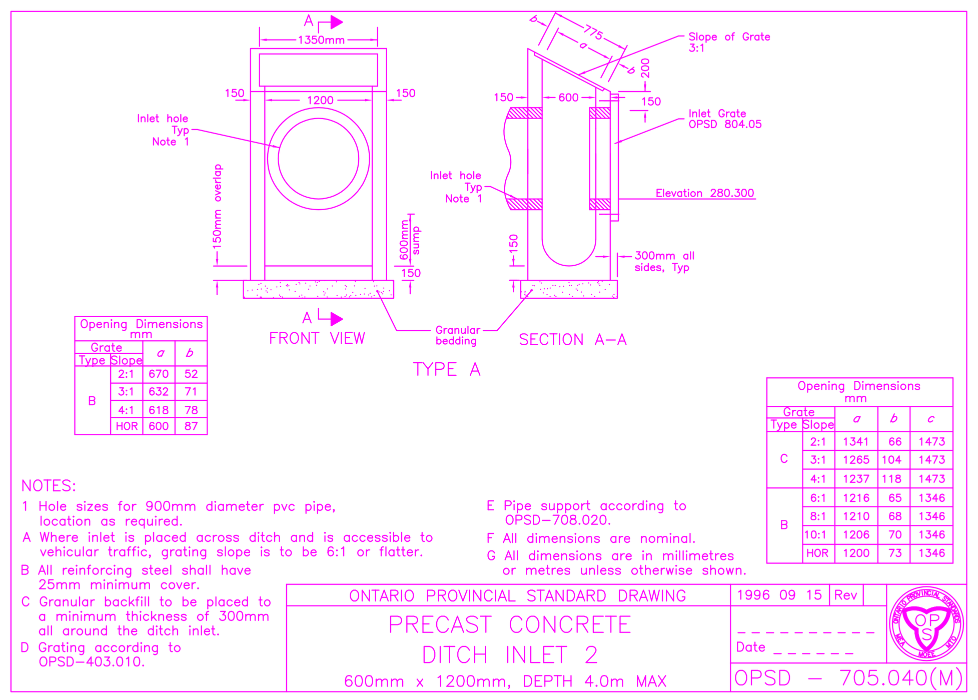


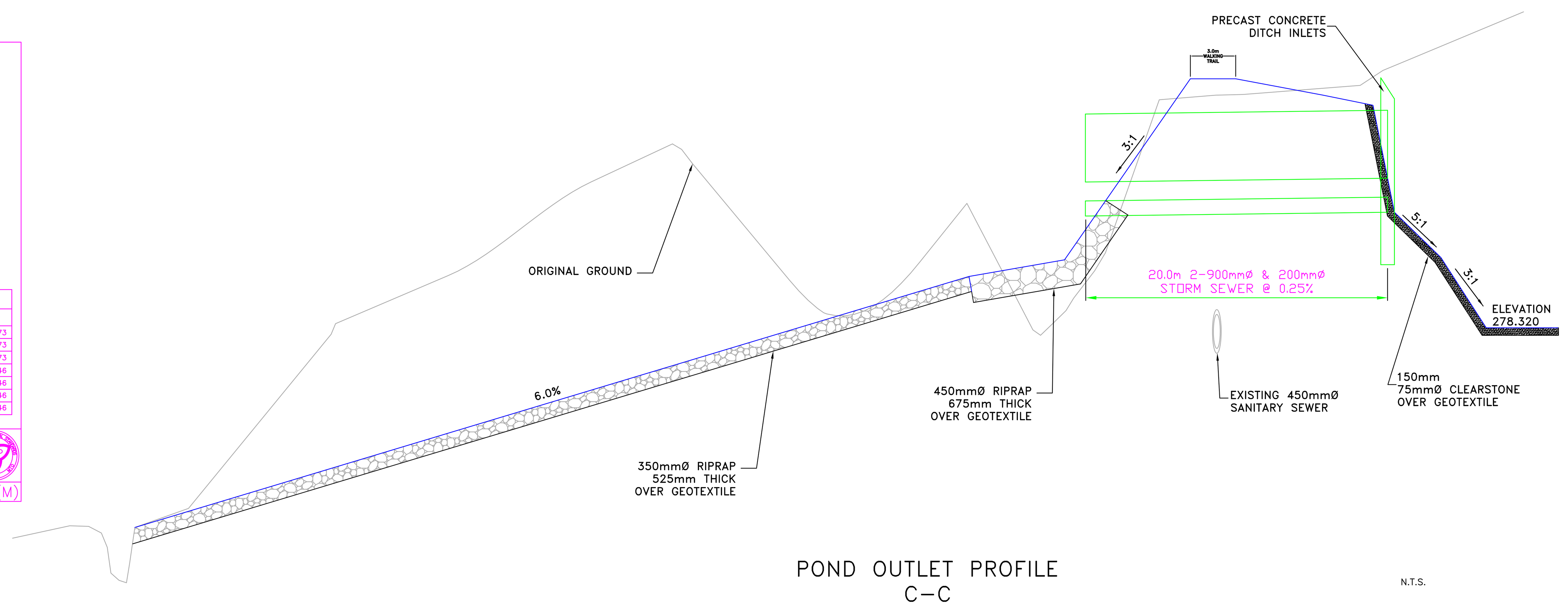












1 A1.01 MASTER SITE PLAN 1:1000

Revision No.	Description	Date
1	ISSUED FOR TENDER	2008.09.24

Check & verify all dimensions before proceeding with work.
Do not scale drawings.

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Project Name
CANADORE COLLEGE NIPISSING UNIVERSITY STUDENT CENTRE
North Bay, Ontario

Drawing Title
STORM WATER MANAGEMENT POND & DETAIL

Scale N.T.S.
Date 04.15.08
Drawn By DN
Checked By
Filename XXX.DWG
Project No. 0408A
Drawing No. C-5